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THE.

SOLUTIONS OF THE QUESTIONS

IN THE

PRINCIPLES AND PRACTICE OF ARITHMETIC.

BY

JOHN HIND, M.A. F.C.P.S. F.R.A.S.

LATE FELLOW AND TUTOR OF SIDNEY SUSSEX COLLEGE, CAMBRIDGE.

SECOND EDITION.

CAMBRIDGE:
DEIGHTON, BELL, AND Co.
LONDON: BELL AND DALDY.
1856.

181. c. 31.

CAMBRIDGE:

PRINTED AT THE UNIVERSITY PRESS.

ELEMENTARY WORKS,

BY THE

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LATE FELLOW AND TUTOR OF SIDNEY SUSSEX COLLEGE, CAMBRIDGE.

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ADVERTISEMENT.

THE appearance of the following Solutions has been suggested by repeated inquiries made both of the Author and his Publishers, as to the existence of such a Work.

The Questions in the first three Chapters have been worked out at full length; and the solutions are accompanied with such Observations as seemed necessary to clear up some little obscurities which the bare enunciation of a Rule could not be expected to reach.

In the fourth Chapter, all the direct Applications of the rules have been omitted, and the Miscellaneous Questions alone considered. the fifth Chapter has been passed over altogether; of the sixth Chapter only such portions have been touched as were deemed likely to throw additional light on their subjects; and the remaining Chapters have been treated upon the same principle.

In the Table of Contents, the numbers on the left are intended to direct the attention to the pages of the Arithmetic, in which the Questions begin to occur: whilst those on the right will, in the ordinary way, point out the pages of the present publication, wherein their Solutions are commenced.

CAMBRIDGE,
February, 1856.

CHAPTER I.

NOTATION.

PAGE 5.

(1) 598.

(2) 7804.

(3) 89063.

(4) 603240.

(5) 9043602.

(6) 45387025.

(7) 349004065.

(8) 100010001.

(9) 842248484.

(10) 909009099.

NUMERATION.

PAGE 8.

(1) Four thousand three hundred and twenty.

(2) Eighty-seven thousand and fifty-four.

(3) Nine hundred and three thousand, seven hundred and fifty-six.

(4) Two million, seven hundred and fourteen thousand, three hundred and twenty-five.

(5) Eight million, forty-seven thousand, three hundred and twenty-eight.

(6) Twelve million, eight hundred and seventy thousand and forty-five.

(7) Twenty million, eighty-four thousand, two hundred and sixteen.

(8) Seventy-nine million, thirty thousand, two hundred and eighty-four.

(9) Three hundred and twenty-one million, four hundred and eight thousand, six hundred and fifty-three.

(10) Four hundred and eight million, seventy-six thousand and thirty-two.

(11) Three hundred and fourteen million, one hundred and fifty-nine thousand, two hundred and sixty-five.

(12) Five hundred and seventy-one million, two hundred and sixty-eight thousand, four hundred and five.

ADDITION.

PAGE 11.

(1) 208. (5) 133. (9) 405.
(2) 995. (6) 780. (10) 1540.
(3) 14115. (7) 6553. (11) 12546.
(4) 160172. (8) 83938. (12) 341709.
(13) 14397.
(14) 1038206.
(15) 268491.
(16) 74147863.
(17) 3300122351: and

Three thousand and three hundred million, one hundred and twenty-two thousand, three hundred and fifty-one.

SUBTRACTION.

PAGE 14.

(1) 6. (7) 127589.
(2) 34. (8) 4699.
(3) 154. (9) 6713076.
(4) 6239. (10) 60005393.
(5) 14759. (11) 10942895.
(6) 327699. (12) 304924818.

MULTIPLICATION.

PAGE 21.

(1) 568.
(2) 4425.
(3) 11468.
(4) 392715.
(5) 246522.
(6) 6599341.
(7) 68290192.
(8) 28951155.
(9) 16155975.
(10) 75398340.

The following Proofs by *casting out the nines* are conducted as in Article (14) of the Appendix.

(11) 21584 × 17 = 366928

151088
21584
366928

(12) 39265 × 39 = 1531335

353385
117795
1531335

(13) 921846 × 158 = 145651668

7374768
4609230
921846
145651668

(14) 827941 × 376 = 311305816

4967646
5795587
2483823
311305816

(15) 5086927 × 495 = 2518028865

25434635
45782343
20347708
2518028865

(16) 279420 × 7350 = 2053737000

139710
83826
195594
2053737000

(17) 254037 × 2980 = 757030260

2032296
2286333
508074

(18) 4785328 × 7802 = 37335129056

9570656
382826240
33497296

(19)

246913578,
493827156,
740740734,
987654312,

370370367,
617283945,
864197523,
1111111101.

(20)

47691 × 9 = 429219
429219 × 3 = 1287657

716281 × 8 = 5730248
5730248 × 6 = 34381488

28573 × 7 = 200011
200011 × 5 = 1000055

129385 × 11 = 1423235
1423235 × 6 = 8539410

138476 × 9 = 1246284
1246284 × 9 = 11216556

480765	8241763
12	11
5769180	90659393
8	11
46153440	997253323
480765	16483526
46634205	1013736849

(21)

4	
7	
28	35
25	29
140	315
56	70
700	1015
	43
13	3045
15	4060
65	43645
13	87
195	305515
17	349160
1365	3797115
195	
3315	

DIVISION.

PAGE 27.

(1) 174.
(2) 1532.
(3) 69071.
(4) 16875.
(5) 8974.
(6) 76782.
(7) 11979052, 1.
(8) 795917072, 3.
(9) 315836, 7.
(10) 112233444, 6.
(11) 823045, 3.

The Proofs of the next two examples, are obtained *solely* by adding together the *final remainders* and *partial subtrahends*, as in Article (15) of the Appendix.

(12) 23) 144157246 (6267706,

138

61

46

155

138

177

161

162

161

146

138

8

144157246 Proof.

(13) 37) 47073256 (1272250,

37

100

74

267

259

83

74

92

74

185

185

6

47073256 Proof.

In all instances, *additional* confirmation of the correctness of the results will arise from the method of *casting out the nines* as in Multiplication, by using the divisor and quotient in the places of the Multiplicand and Multiplier, and the excess of the dividend above the remainder in the place of the Product.

(14) 549) 48310567 (87997,

4392

4390

3843

5475

4941

5346

4941

4057

3843

214

48310557 Proof.

or, 7 − 7

(15) 7038) 140167329 (19915,

7038

69787

63342

64453

63342

11112

7038

40749

35190

5559

140167329 Proof.

or, 6 − 6

(16) 79,00) 25413286 (3216,
237
171
158
133
79
542
474
6886
25413286 Proof.

$$\begin{array}{ccc} & 3 & \\ 7 & & 3 \\ & 3 & \end{array}$$

or, 4 − 1

(17) 573,0) 8327970 (1453,
573
2597
2292
3059
2865
1947
1719
2280
8327970 Proof.

$$\begin{array}{ccc} & 6 & \\ 6 & & 4 \\ & 6 & \end{array}$$

or, 9 − 3

(18) 148,0) 64157600 (43349,
592
495
444
517
444
736
592
1440
1332
1080
64157600 Proof.

$$\begin{array}{ccc} & 2 & \\ 4 & & 5 \\ & 2 & \end{array}$$

or, 2 − 0

These seven examples should be worked out by the *Italian Method*, explained in Article (16) of the Appendix.

(19) $32 \begin{cases} 4) \ 76294 \\ 8) \ 19073, 2 \\ \hline 2384, 1 \end{cases}$ remainder $= 1 \times 4 + 2 = 6.$

$49 \begin{cases} 7) \ 729518 \\ 7) \ 104216, 6 \\ \hline 14888, 0 \end{cases}$ remainder $= 0 \times 7 + 6 = 6.$

$66 \begin{cases} 6) \ 8015473 \\ 11) \ 1335912, 1 \\ \hline 121446, 6 \end{cases}$ remainder $= 6 \times 6 + 1 = 37.$

$121 \begin{cases} 11) \ 4050873 \\ 11) \ 368261, 2 \\ \hline 33478, 3 \end{cases}$ remainder $= 3 \times 11 + 2 = 35.$

Of two unequal divisors thus used, it will, for obvious reasons, be desirable to apply the smaller first: and the remainders may be calculated *mentally* without putting down the *processes* above exhibited.

GREATEST COMMON MEASURES.

PAGE 31.

(1) $9) \ 24$

$2, 6) \ 9$

$1, 3) \ 6$

2

whence, 3 is the greatest common measure.

(2)
$$\begin{array}{r} 126\overline{)144}\,(1 \\ \underline{126} \\ 18\overline{)126}\,(7 \\ \underline{126} \end{array}$$

whence, 18 is the greatest common measure.

(3)
$$\begin{array}{r} 3444\overline{)3556}\,(1 \\ \underline{3444} \\ 112\overline{)3444}\,(30 \\ \underline{336} \\ 84\overline{)112}\,(1 \\ \underline{84} \\ 28\overline{)84}\,(3 \\ \underline{84} \end{array}$$

whence, 28 is the greatest common measure.

(4)
$$\begin{array}{r} 5187\overline{)5850}\,(1 \\ \underline{5187} \\ 663\overline{)5187}\,(7 \\ \underline{4641} \\ 546\overline{)663}\,(1 \\ \underline{546} \\ 117\overline{)546}\,(4 \\ \underline{468} \\ 78\overline{)117}\,(1 \\ \underline{78} \\ 39\overline{)78}\,(2 \\ \underline{78} \end{array}$$

whence, 39 is the greatest common measure.

(5) 6441) 10283 (1
6441
3842) 6441 (1
3842
2599) 3842 (1
2599
1243) 2599 (2
2486
113) 1243 (1
113
113
113

whence, 113 is the greatest common measure.

(6) 13667) 14186 (1
13667
519) 13667 (26
1038
3287
3114
173) 519 (3
519

whence, 173 is the greatest common measure.

(7) 43365) 44688 (1
43365
1323) 43365 (32
3969
3675
2646
1029) 1323 (1
1029
294) 1029 (3
882
147) 294 (2
294

whence, 147 is the greatest common measure.

(8) 11050) 35581 (3
33150
2431) 11050 (4
9724
1326) 2431 (1
1326
1105) 1326 (1
1105
221) 1105 (5
1105

whence, 221 is the greatest common measure.

(9) 109056) 179712 (1
109056
70656) 109056 (1
70656
38400) 70656 (1
38400
32256

$$
\begin{array}{r}
32256\,)\,38400\,(1 \\
32256 \\
\hline
6144\,)\,32256\,(5 \\
30720 \\
\hline
1536\,)\,6144\,(4 \\
6144 \\
\hline
\end{array}
$$

whence, 1536 is the greatest common measure.

(10) Since 8 is the G.C.M. of 16 and 24, we have to find the G.C.M. of 8 and 140, by the ordinary process, and it is 4.

(11) The G.C.M. of 13338 and 14136 is 114, whence the G.C.M. required is that of 114 and 15903, which is 57.

(12) The G.C.M. of 204 and 1190 is 34: also, of 1445 and 2006 it is 17, which is the G.C.M. sought.

LEAST COMMON MULTIPLES.

PAGE 33.

(1) The G.C.M. is 3, and therefore the least common multiple is $12 \times 27 \div 3$, or $= \frac{12 \times 27}{3} = 4 \times 27 = 108$.

(2) The G.C.M. is 17; whence, the L.C.M.

$$= \frac{289 \times 323}{17} = 17 \times 323 = 5491.$$

(3) The G.C.M. is 283, so that the L.C.M.

$$= \frac{849 \times 1132}{283} = 849 \times 4 = 3396.$$

(4) The L.C.M. of 3 and $4 = \frac{3 \times 4}{1} = 12$: the L.C.M. of 12 and $16 = \frac{12 \times 16}{4} = 12 \times 4 = 48$.

(5) The L.C.M. of 24 and $39 = \frac{24 \times 39}{3} = 312$: the L.C.M. of 312 and $376 = \frac{312 \times 376}{8} = 14664$.

(6) The L.C.M. of 12 and $15 = \frac{12 \times 15}{3} = 60$: the L.C.M. of 60 and $35 = \frac{60 \times 35}{5} = 420$: the L.C.M. of 420 and $56 = \frac{420 \times 56}{28} = 840$.

PAGE 33.

(1) 45. (2) 72. (3) 1890. (4) 1260. (5) 7560.

CHAPTER II.

REDUCTION.

PAGE 36.

(1) £71. 13*s*. 6½*d*.

20
1433
12
17202
4
68810*f*.

4) 68810*f*.
12) 17202½
2,0) 143,3.6
£71.13.6½

(2) 95*g*. 17*s*. 9¾*d*.

21
2012
12
24153
4
96615*f*.

4) 96615*f*.
12) 24153¾
21 { 3) 2012.9
7) 670.2
g. 95.17.9¾

(3) £295. 18*s*. 3¾*d*.

20
5918
12
71019
4
284079*f*.

4) 284079*f*.
12) 71019¾
2,0) 591,8.3
£295.18.3¾

(4) 4) 415739 *f.*
12) 103934 $\frac{3}{4}$
2,0) 866,1.2
£433.1.2 $\frac{3}{4}$

£433. 1*s.* 2 $\frac{3}{4}$*d.*
20
8661
12
103934
4
415739

(5) 14cwt. 3qrs. 24lbs.
4
59
28
476
120.
1676
16
10056
1676
26816 oz.

16 { 2) 26816 oz.
8) 13408
28 { 4) 1676
7) 419
4) 59.24
cwt. 14.3.24

(6) 11cwt. 2qr. 17lb. 15oz.
4
46
28
375
93
1305
16
7835
1306
20895 oz.

16 { 2) 20895 oz.
8) 10447.1
28 { 4) 1305.15
7) 326.1
4) 46.17
cwt. 11.2.17.15

(7)

16 { 2) 65437 drs.
8) 32718.1

16 { 4) 4089.13
4) 1022.1

28 { 4) 255.9
7) 63.3
4) 9.3

cwt. 2.1.3.9.13

2cwt.1qr.3lbs.9oz.13dr.
4
9
28
255
16
4089
16
65437 drs.

(8) 3 tons 14 cwt. 3 qrs. 25 lbs. 11 oz. 9 drs.

20
74
4
299
28
8397
16
134363
16
2149817 drs.

16 { 2) 2149817 drs.
8) 1074908.1

16 { 2) 134363.9
8) 67181.1

28 { 4) 8397.11
7) 2099.1
4) 299.25
2,0) 7,4.3

tons 3.14.3.25.11.9

(9) 15 mi. 5 fur. 31 po.

8
125
40
5031 po.

4,0) 503,1
8) 125.31
mi. 15.5.31

(10)
12) 1081080 in.
3) 90090
20) 30030
160 { 8) 1501.10
11) 187.110
1760 { mi. 17.110

17 mi. 110 yds.
1760
30030
3
90090
12
1081080 in.

(11)
3) 304935 ft.
20) 101645
220 { 11) 5082.5
8) 462.5
mi. 57.6.5

57 mi. 6 fur. 5 yds.
8
462
220
101645
3
304935 ft.

(12)
512 yds. 2 ft. 9 in.
3
1538
12
18465 in.

12) 18465 in.
3) 1538.9
yds. 512.2.9

(13)
54 yds. 8 ft. 104 in.
9
494
144
71240 in.

(14)
12) 40253798 in.
144 { 12) 3354483.2
9) 279540.38
yds. 31060.38

(15)
$$1728\left\{\begin{array}{l}12)\ 141721\text{ in.}\\ \hline 12)\ 11810.1\\ \hline 12)\ 984.25\\ \hline 27\left\{\begin{array}{l}3)\ 82.25\\ \hline 5)\ 27.1\end{array}\right.\end{array}\right.$$
yds. 3.1.25

3 yds. 1 ft. 25 in.
27
82
1728
141721 in.

(16)
2) 5279 pts.
4) 2639.1
gals. 659.3.1

659 gals. 3 qts. 1 pt.
4
2639
2
5279 pts.

(17)
$$24\left\{\begin{array}{l}4)\ 72015\text{ hrs.}\\ \hline 6)\ 18003.3\end{array}\right.$$
7) 3000.15
wks. 428.4.15

428 wks. 4 da. 15 hrs.
7
3000
24
72015 hrs.

(18)
6,0) 270635,9 sec.
6,0) 4510,5.59
$$24\left\{\begin{array}{l}4)\ 751.45\\ \hline 6)\ 187.3\end{array}\right.$$
7) 31.7
wks. 4.3.7.45.59

wks. da. hrs. min. sec.
4 . 3 . 7 . 45 . 59
7
31
24
751
60
45105
60
2706359 sec.

(19) 6,0) 20626,5 sec.
6,0) 343,7 . 45″
57°. 17′. 45″

57°. 17′. 45″
60
3437
60
206265

(20)

lbs.	oz.	dwts.	grs.
12	. 10	. 15	. 14

12
154
20
3095
24
74294 grs.

24 { 4) 74294 grs.
6) 18573 . 2
2,0) 309,5 . 14
12) 154 . 15
lbs. 12 . 10 . 15 . 14

(21)

lbs.	oz.	dr.	scr.	grs.
18	. 2	. 4	. 2	. 12

12
218
8
1748
3
5246
20
104932 grs.

2,0) 10493,2 grs.
3) 5246 . 12
8) 1748 . 2
12) 218 . 4
lbs. 18 . 2 . 4 . 2 . 12

(22) 20 yds. 3 qrs. 1 nl.
4
83
4
333 nls.

4) 333 nls.
4) 83 . 1
yds. 20 . 3 . 1

(23) 4,0) 8297,3 po.
4) 2074 . 13
ac. 518 . 2 . 13

518 ac. 2 ro. 13 po.
4
2074
40
82973 po.

(24)
bar.	gals.	qts.	pt.
987	. 25	. 3	. 1

36
35557
4
142231
2
284463 pts.

2) 284463 pts.
4) 142231 . 1
36 { 3) 35557 . 3
12) 11852 . 1
bar. 987 . 25 . 3 . 1

(25)
tuns	hhds.	gals.	qts.
21	. 3	. 54	. 2

4
87
63
5535
4
22142
2
44284 pts.

2) 44284 pts.
4) 22142
63 { 7) 5535 . 2
9) 790 . 5
4) 87 . 54
tuns 21 . 3 . 54 . 2

(26)

qrs.	bu.	pks.	gal.
356	. 7	. 2	. 1
8			
2855			
4			
11422			
2			
22845			
4			
91380 qts.			

4) 91380 qts.
2) 22845
4) 11422 . 1
8) 2855 . 2
qrs. 356 . 7 . 2 . 1

(27) First, 17*s.* 6*d.* = 210*d.*:
then, 210*d.* × 340 = 71400*d.* = £297. 10*s.*

(28) First, 198*gs.* = 198 × 21 = 4158*s.*
then, 4158*s.* ÷ 27 = 154 moidores.

(29) First, 3*s.* 4*d.* = 40*d.*, £453. 16*s.* 8*d.* = 108920*d.*: then, 108920 ÷ 40 = 2723 pieces.

(30) First, 2 ft. 10 in. = 34 in.: 10 mi. 140 yds. = 638640 in.: then, 638640 ÷ 34 = 18783 times, and 18 in. over.

(31) First, 14 oz. 13 drs. = 237 drs.: 25 cwt. 2 qrs. 14 lbs. = 734720 drs.: then, 734720 ÷ 237 = 3100 times, and 20 drs. = 1 oz. 4 drs. over.

(32) First, 4 ft. 7 in. = 55 in.: 2 mi. 4 fur. = 158400 in.: then, 158400 ÷ 55 = 2880 revolutions.

(33) First, 2 fur. 20 po. = 100 po. is the length into which 5 oz. of silk is spun: and therefore 20 po. is the length into which 1 oz. will be spun: also, 240000 mi. = 76800000 po.: whence, the weight sought will evidently be 76800000 ÷ 20 = 3840000 oz. = 107 tons, 2 cwt. 3 qrs 12 lbs.

(34) First, we have 365 days, 6 hrs. = 31557600 sec.: and thence 295402374 ÷ 31557600 = 9 yrs. and 11383974 sec. over: or 9 yrs. 131 days, 18 hrs. 12 min. 54 sec.

PAGES 39 and 41.

Compound Addition and Subtraction are omitted.

COMPOUND MULTIPLICATION.

PAGE 43. Examples (1)—(5) are omitted.

(6)

£.	s.	d.
125	15	$9\frac{1}{4}$
		$7 \times 4 = 28$
880	10	$4\frac{3}{4}$
		4
£3522	1	7

£.	s.	d.
125	15	$9\frac{1}{4}$
		$9 \times 5 = 45$
1132	1	$11\frac{1}{4}$
		5
£5660	9	$8\frac{1}{4}$

(7)

£.	s.	d.	
53	18	$7\frac{3}{4}$	
		$10 \times 5 + 1 = 51$	
539	6	$5\frac{1}{2}$	
		5	
2696	12	$3\frac{1}{2}$	
53	18	$7\frac{3}{4}$	add.
£2750	10	$11\frac{1}{4}$	

£.	s.	d.	
53	18	$7\frac{3}{4}$	
		$12 \times 7 - 1 = 83$	
647	3	9	
		7	
4530	6	3	
53	18	$7\frac{3}{4}$	subtract.
£4476	7	$7\frac{1}{4}$	

(8)

cwt.	qrs.	lbs.	oz.	
17	2	19	5	
			$12 \times 3 = 36$	
212	0	7	12	
			3	
cwt. 636	0	23	4	

cwt.	qrs.	lbs.	oz.	
17	2	19	5	
				$12 \times 6 + 1 = 73$
212	0	7	12	
			6	
1272	1	18	8	
17	2	19	5	add.
cwt. 1290	0	9	13	

(9)

lea.	mi.	fur.	po.	
13	2	6	25	
			7	
97	1	6	15	
			6	
lea. 585	1	6	10	

lea.	mi.	fur.	po.
13	2	6	25
			12
167	0	7	20
			8
1338	1	4	0
13	2	6	25
lea. 1352	1	2	24

(10)

qrs.	bu.	pks.	gal.	
15	6	3	1	
			9	
142	5	3	1	
			6	
qrs. 856	3	1	0	

qrs.	bu.	pks.	gal.
15	6	3	1
			11
174	3	2	1
			10
1744	4	1	0
15	6	4	1
qrs. 1760	3	0	1

(11)

da.	hrs.	min.
43	18	45
		11
481	14	15
		7
da. 3371	3	45

da.	hrs.	min.
43	18	45
		7
306	11	15
		7
2145	6	45
		3
da. 6435	20	15

Example (12) is omitted.

(13)

s.	d.
13	8
	12
8	4 . 0
	6
£49	4 . 0

(14)

s.	d.
5	$3\frac{3}{4}$
	12
3	3 . 9
	10
£31	17 . 6

(15)

yds.	qrs.	nls.
42	2	2
		10
426	1	0
		4
yds. 1705	0	0

(16)

£.	s.	d.	
3	7	$10\frac{1}{2}$	
		10	
33	18	9	
		7	} 280
237	11	3	
		4	
950	5	0	
3	7	$10\frac{1}{2}$	sub.
£946	17	$1\frac{1}{2}$	
		2	

(17)

£.	s.	d.	
2	7	$1\frac{1}{2}$	
		12	
28	5	6	
		6	73
169	13	0	
2	7	$1\frac{1}{2}$	
172	0	$1\frac{1}{2}$	
		5	
£860	0	$7\frac{1}{2}$	

(18)

£.	s.	d.	
32	5	6	
		10	
322	15	0	
		5	53
1613	15	0	
96	16	6	
1710	11	6	
		10	
17105	15	0	
		4	40
£68423	0	0	

(19)

£.	s.	d.	
1	18	$6\frac{1}{2}$	
		11	
21	3	$11\frac{1}{2}$	
		10	
211	19	7	
7	14	2	
£219	13	9	

(20)

	oz.	dwts.	
	51	10	
		6	
lbs.	25	9	0 dishes.

	oz.	dwts.	grs.	
	15	15	22	
			12	
	15	9	11	0 plates:
	25	9	0	0 dishes:
lbs.	41	6	11	0 total.

(21)

5 yds.	1	ft.	6	in.
			8	
44	0	0		
			8	640
352	0	0		
			10	64000
3520	0	0		
			10	
35200	0	0		
			10	
352000	0	0		
3520	0	0		add.
yds. 355520	0	0		= 202 miles.

COMPOUND DIVISION.

PAGE 46. Examples (1)—(7) are omitted.

£.	s.	d.	£.	s.	d.
23) 1279	13	$8\frac{3}{4}$	(55	12	$9\frac{1}{4}$
115					
129					
115					
14					
20					
293					
23					
63					
46					
17					
12					
212					
207					
5					
4					
23					
23					

(8) 18 ⟨ 2) 1738 . 12 . $7\frac{1}{2}$; 9) 869 . 6 . $3\frac{3}{4}$; £96 . 11 . $9\frac{3}{4}$

(9) 27 ⟨ 3) 425 . 15 . 2 . 12 ; 9) 141 . 18 . 2 . 4 ; tons 15 . 15 . 1 . 16

(10) 28 ⟨ 4) 1361 . 4 . 28 ; 7) 340 . 3 . 7 ; mi. 48 . 5 . 1

(9) 38) 2374 cwt. . 1 qr. . 12 lbs. . 12 oz. (62 cwt. . 1 qr. . 26 lbs. . 2 oz.

228

94
76

18
4

73
38

35
28

992
76

232
228

4
16

76
76

(10) 46) 3179 lea. . 1 mi. . 5 fur. . 16 po. (69 lea. . 0 mi. . 2 fur. . 36 po.

276

419
414

5
3

16
8

133
92

41
40

1656
138

276
276

(11)

£.	s.	d.	£.	s.	d.
41) 52	. 10	. $7\frac{1}{2}$ (	1	. 5	. $7\frac{1}{2}$

41
11
20
230
205
25
12
307
287
20
4
82
82

(12)

£.	s.	d.
4) 137	. 18	. 0
4) 34	. 9	. 6
7) 8	. 12	. $4\frac{1}{2}$
£1	. 4	. $7\frac{1}{2}$

112

(13)

£.	s.	d.	£.	s.	d.
5) 9	. 2	. 6			
73) 1	. 16	. 6 (	0	. 0	. 6

365

20
36
12
438
438

(14) £. s. d.
65 . 12 . 6 = yearly Income:
20 . 0 . 0 = yearly Saving:
£45 . 12 . 6 = yearly Expenditure:

365) £. s. d. (£. s. d.
45 . 12 . 6 (0 . 2 . 6
20
912
730
182
12
2190
2190

(15) 145) £. s. d. (£. s. d.
169 . 3 . 4 (1 . 3 . 4 = price of a sheep.
145 10
24 11 . 13 . 4
20 2
483 £23 . 6 . 8 = price of a score.
435
48
12
580
580

(16) 514) 1 mi. 467 yds. 1 ft. (4 yds. 1 ft.
1760
2227
2056
171
3
514
514

(17) 37) 422 mi. 3 fur. 38 po. (11 mi. 3 fur. 14 po.

37

52

37

15

8

123

111

12

40

518

37

148

148

(18) 8) 6656 = price of 8 packages:

4) 832 = price of 1 package or 4 parcels:

10) 208 = price of 1 parcel or 10 pieces:

£20 . 16 = price of 1 piece or 26 yards:

whence, we have now only to perform the remaining part of the process by *Long Division.*

£. s.

26) 20 . 16 . (16*s.* = price of 1 yard.

20

416

26

156

156

(19)

£.	s.	d.	£.	s.	d.
754) 3178	. 11	. $7\frac{1}{2}$	(4	. 4	. $3\frac{3}{4}$

3016

162

20

3251

3016

235

12

2827

2262

565

4

2262

2262

(20) 138 gals. at 10*s.* a gallon cost £69, which is the retail price of 138 − 18 = 120 gallons sold: whence, we have

		£.	s.	d.
120	10)	69 .	0 .	0
	12)	6 .	18 .	0
		£0 .	11 .	6

(21)

50 men.

30

1500

2

3000

500

50) 250,0

50) 50

1 qt.

CHAPTER III.

THE RULE OF THREE.

PAGE 55.

(1) 1 lb. : 450 lbs. :: 4*s.* 8½*d.*

12

56

4

or, 1 : 450 :: 226*f.*

450

4) 101700*f.*

12) 25425

2,0) 211,8 . 9

£105 . 18 . 9

(2) 1 da. : 215 da. :: 2*s.* 4¼*d.*

12

28

4

or, 1 : 215 :: 113*f.*

113

4) 24295*f.*

12) 6073¾

2,0) 50,6 . 1

£25 . 6 . 1¾

(3) £191. 12*s.* 6*d.* : £31. 10*s.* :: 365 days,
or, 45990*d.* : 7560*d.* :: 365
or, 4599 : 756 :: 365
or, 511 : 84 :: 365
or, 73 : 12 :: 365
or, 1 : 12 :: 5
5
60 days.

(4) 25 cwt. 2 qrs. : 1 cwt. :: £7. 6*s.* 7½*d.*
or, 102 qrs. : 4 qrs. :: 7038*f.*
or, 51 : 2 :: 7038
or, 17 : 2 :: 2346
2
17) 4692 (276*f.*
34 12) 69 *d.*
129 *s.* 5 . 9
119
102
102

(5) 1 lb. : 4 cwt. 1 qr. 4 lbs. 8 oz. :: 7*s.* 10½ *d.*
or, 16 oz. : 7688 oz. :: 378*f.*
or, 2 : 961 :: 378
or, 1 : 961 :: 189
189
4) 181629*f.*
12) 45407¼
2,0) 378,3 . 11
£189 . 3 . 11¼

(6) 6 yds. 3 qrs. : 73 yds. 2 qrs. :: 5*s.* 3*d.*
or, 27 qrs. : 294 qrs. :: 63*d.*
or, 9 : 98 :: 63
or, 1 : 98 :: 7
7
12) 686*d.*
2,0) 5,7 . 2
£2 . 17 . 2

(7) £19. 1*s.* : £23. 16*s.* 3*d.* :: 20 days,
or, 4572*d.* : 5715*d.* :: 20 days,
or, 508 : 635 :: 20
or, 127 : 635 :: 5
or, 1 : 5 :: 5
5
25 days.

(8) 12 hrs. : 16 hrs. :: 7 days,
or, 3 : 4 :: 7
7
3) 28
days 9 . 4 hrs.

(9) 100 Fr. deg. : 654 Fr. deg. :: 90 En. deg.
or, 10 : 654 :: 9
9
10) 5886
deg. 588 . 36 min.

(10) 17 ells 3 qrs. : 18 yds. :: £6. 17*s*. 6*d*.
or, 88 qrs. : 72 qrs. :: 1650*d*.
or, 11 : 9 :: 1650
or, 1 : 9 :: 150

$$\begin{array}{r} 9 \\ \hline 12) \; 1350d. \\ \hline 2,0) \; 11,2.6 \\ \hline £5 \,.\, 12 \,.\, 6 \end{array}$$

(11) 1000 : 384 :: 21 lbs. 5 oz. 16 dwts. 6 grs.
or, 1000 : 384 :: 123750 grs.
or, 100 : 384 :: 12375
or, 20 : 384 :: 2475
or, 4 : 384 :: 495
or, 1 : 96 :: 495

$$\begin{array}{r} 96 \\ \hline 2970 \\ 4455 \\ \hline 24 \begin{cases} (4) \; 47520 \\ \hline (6) \; 11880 \end{cases} \\ \hline 2,0) \; 1980 \\ \hline 12) \; 99 \\ \hline \text{lbs. } 8. \; 3 \text{ oz.} \end{array}$$

(12) 6*s*. 9½*d*. : £55. 0*s*. 3*d*. :: 1 bush.
or, 326*f*. : 52812*f*. :: 1 bush.
or, 163 : 26406 :: 1

$$\begin{array}{r} 1 \\ \hline 163) \; 26406 \; (162 \text{ bush.} \\ 163 \\ \hline 1010 \\ 978 \\ \hline 326 \\ 326 \\ \hline \end{array} \qquad \text{qrs. } 20 \,.\, 2 \text{ bush.}$$

(13) 375 ac. : 1 ac. :: £401. 11*s.* 3*d.*
or, 375 : 1 :: 96375*d.*
or, 75 : 1 :: 19275
or, 15 : 1 :: 3855
or, 3 : 1 :: 771
or, 1 : 1 :: 257
1
12) 257*d.*
2,0) 2,1 . 5
£1 . 1 . 5

(14) 7 days : 273 days :: 13*s.* 6*d.*
or, 7 : 273 :: 162*d.*
or, 1 : 39 :: 162
39
1458
486
12) 6318*d.*
2,0) 52,6 . 6
£26 . 6 . 6

(15) 2 cwt. 2 qrs. 10 lbs. : 36 cwt. 1qr. :: £4. 7*s.* 9½*d.*
or, 290 lbs. : 4060 lbs. :: 4214*f.*
or, 29 : 406 :: 4214
or, 1 : 14 :: 4214
14
4) 58996*f.*
12) 14749
2,0) 122,9 . 1
£61 . 9 . 1

(16) 365 days : 338 days :: £30. 0*s.* 8¾*d.*
or, 365 : 338 :: 28835*f.*
or, 73 : 338 :: 5767
338
73) 1949246
4) 26702*f.*
12) 6675½
2,0) 55,6 . 3
£27 . 16 . 3½

(17) 3 mi. 6 fur. 25 po. : 99 mi. 4 fur. 10 po. :: 1 hr.
or, 1225 po. : 31850 po. :: 1 hr.
or, 245 : 6370 :: 1
or, 49 : 1274 :: 1
or, 7 : 182 :: 1
or, 1 : 26 :: 1
1
26 hours.

(18) 1 qt. : 19 bar. 24 gals. 3 qts. 1 pt. :: 3½*d.*
or, 2 pts. : 5671 pts. :: 14*f.*
or, 1 : 5671 pts. :: 7
7
4) 39697*f.*
12) 9924¼
2,0) 82,7 . 0¼
£41 . 7 . 0¼

(19) 3 cwt. 2 qrs. 14 lbs. : 10 tons, 3 cwt. :: 18*s.* 5¼*d.*
or, 406 lbs. : 22736 lbs. :: 885*f.*
or, 58 : 3248 :: 885
or, 29 : 1624 :: 885

885
29) 1437240 (49560*f.*
116 12) 12390
277 2,0) 103,2 . 6
261 £51 . 12 . 6
162
145
174
174

(20) £3840 : £1 :: £828
or, 960 : 1 :: £207
or, 320 : 1 :: £69
or, 320 : 1 :: 1380*s.*
or, 80 : 1 :: 345
or, 16 : 1 :: 69

1
16 { 2) 69
8) 34 . 1
s. 4 . 3¾

(21) £1 : £2735 . 10*s.* :: 11*s.* 7½*d.*
or, 20*s.* : 54710*s.* :: 558*f.*
or, 2 : 5471 :: 558
or, 1 : 5471 :: 279

279
49239
38297
10942
4) 1526409*f.*
12) 381602¼
2,0) 3180,0 . 2
£1590 . 0 . 2¼

(22) 8*s.* : 6*s.* :: 2*s.*
or, 8 : 6 :: 2*s.*
or, 4 : 3 :: 2
or, 2 : 3 :: 1
1
2) 3
s. 1 . 6

(23) 5*s.* 6*d.* : £100 :: 1*s.* 4½*d.*
or, 4 : 100 :: 1
or, 1 : 25 :: 1
1
£25

(24) 25 men : 15 men :: 25 days
or, 25 : 15 :: 25 days
or, 1 : 15 :: 1
1
15 days.

(25) 3 ft. 9 in. : 7 ft. 6 in. :: 37 ft. 9 in.
or, 1 : 2 :: 37 ft. 9 in.
2
75 ft. 6 in.

(26) 8 yds. 2 qrs. 2 nls. : 69 yds. :: 3 qrs.
or, 138 nls. : 1104 nls. :: 3 qrs.
or, 1 : 8 :: 3 qrs.
8
4) 24 qrs.
6 yds.

(27) £89. 2*s*. 6*d*. : £1002. 13*s*. 1½*d*. :: £3
or, 85560*f*. : 962550*f*. :: £3
or, 8556 : 96255 :: £3
or, 2852 : 32085 :: 3

3

2852) 96255 (£33. 15*s*.
8556
10695
8556
2139
20
42780
2852
14260
14260

(28) £2. 15*s*. : £3223 :: £100
or, 55*s*. : 64460*s*. :: £100
or, 11 : 12892 :: £100
or, 1 : 1172 :: 100

100

£117200

(29) 1 wk. : 52 wks. :: £10. 13*s*. 9½*d*.
or, 1 : 52 :: 10262*f*.

52

4) 533624*f*.
12) 133406
2,0) 1111,7.2
£555 . 17 . 2

whence, £682 . 10 . 0 = annual income:
and, 555 . 17 . 2 = annual expenditure:
therefore, £126 . 12 . 10 = annual saving.

(30) Here, £1000 . 0 . 0 = annual income:
and, 434 . 5 . 0 = annual saving:
therefore, £565 . 15 . 0 = annual expenditure:
whence, 365 days : 1 day :: £565. 15*s.*
or, 365 : 1 :: 11315*s.*
or, 73 . 1 :: 2263*s.*
or, 1 : 1 :: 31 = £1. 11*s.*

(31) £187. 10*s.* : £250 :: 6 mo.
or, 3750*s.* : 5000*s.* :: 6 mo.
or, 75 : 100 :: 6 mo.
or, 3 : 4 :: 6 mo.
or, 1 : 4 :: 2
2
8 months.

(32) £429. 8*s.* 3*d.* : £302. 3*s.* 7*d.* :: 13*s.* 6*d.*
or, 103059*d.* : 72523*d.* :: 162*d.*
or, 11451 : 72523 :: 18*d.*
or, 3817 : 72523 :: 6
6
3817) 435138 (114*d.*
3817 9*s.* 6*d.*
5343
3817
15268
15268

(33) £763. 15*s.* : £1. :: £133. 13*s.* 1½*d.*
or, 15275*s.* : 20*s.* :: 128310*f.*
or, 3055 : 4 :: 128310*f.*
or, 611 : 4 :: 25662

4

611) 102648 (168*f.*
611 12) 42*d.*
4154 3*s.* 6*d.*
3666
4888
4888

(34) 1 yd. : 136 yds. :: £1. 18*s.*
or, 1 : 136 :: 38*s.*

38

2,0) 516,8*s.*

£258 . 8 = retail price :
150 . 0 = prime cost :
£108 . 8 = gain.

(35) 1 day : 365 days :: £1. 15*s.*
or, 1 : 365 :: 35*s.*

35

2,0) 1277,5*s.*

£638 . 15 = annual income :

1 qr. : 4 qrs. :: £135 . 10*s.*

4

£542 . 0 = annual expenditure : whence, we have now the following simple conclusion :

£638 . 15 = annual income :
542 . 0 = annual expenditure :
therefore, 96 . 15 = saving in 1 year :

9

£870 . 15 = saving in 9 years.

(36) 1 wk. : 52 wks. :: £152 . 10*s.*
or, 1 : 52 :: 3050*s.*

52

2,0) 15860,0*s.*

£7930 = exp. in 1 year:
15

118950 = exp. in 15 years:
7522 . 10 = saving in 15 yrs.:

15) 126472 . 10 = income in 15 yrs.:

£8431 . 10 = income in 1 yr.:

whence, 365 days : 1 day :: £8431. 10*s.*
or, 365 : 1 :: 168630*s.*
or, 73 : 1 :: 33726

1

73) 33726 (462*s.*
292 £23.2
452
438
146
146

(37) 12*s.* 6*d.* : £125 :: 1 gal.
or, 150*d.* : 30000*d.* :: 1 gal.
or, 1 : 200 :: 1 gal.

1

200 = gallons sold:
180 = gallons bought:
20 = gallons of water.

(38) Instead of £1, the sum of 16*s.* 6*d.* only is clear income: whence, we have

£1 : £1680 :: 16*s.* 6*d.*
or, 1 : 1680 :: 198*d.*
198
12) 332640*d.*
2,0) 2772,0
£1386

(39) The aggregate of the three dividends will be 4*s.* 2¼*d.* + 3*s.* 2¼*d.* + 2*s.* 4½*d.* = 9*s.* 9*d.* in the pound, so that the creditors lose 10*s.* 3*d.* in the pound: whence we have

£1 : £4265 :: 10*s.* 3*d.*
or, 1 : 4265 :: 123*d.*
123
12) 524595*d.*
2,0) 4371,6 . 3
£2185 . 16 . 3

(40) 2 yds. : 125 yds. :: 5*s.*
5
2) 625
312*s.* 6*d.* = cost in the first bargain:
3 yds. : 125 yds. :: 5*s.*
5
3) 625
208*s.* 4*d.* = cost in the second bargain;

therefore, the whole prime cost amounts to 520*s.* 10*d.*:

also, 5 yds. : 250 yds. :: 10*s.*
or, 1 : 50 :: 10*s.*
10

500*s.* = the retail price of the whole:

which being *less* than 520*s.* 10*d.* by 20*s.* 10*d.* = £1. 0*s.* 10*d.* shews that the last-mentioned sum is *lost* by the transaction.

THE DOUBLE RULE OF THREE.

PAGE 60.

(1) 7 persons : 10 persons :: 70 gs.
or, 1 : 10 :: 10 gs.
10

100 gs. = the expenditure of 10 persons for 3 months: whence, we have

3 mo. : 12 mo. :: 100 gs.
or, 1 : 4 :: 100 gs.
100

400 gs. = £420 = the expenditure of 10 persons for 12 months.

(2) 10 horses : 28 horses :: 7 bush. 2 pks.
or, 5 : 14 :: 30 pks.
30

5) 420

84 pks. = the quantity of oats consumed by 28 horses in 7 days: then we have

84 pks. : 3 qrs. 6 bush. :: 7 days
or, 84 pks. : 120 pks. :: 7 days
or, 7 : 10 :: 7 days
or, 1 : 10 :: 1

1

10 days.

(3) 20 ac. : 70 ac. :: 10 men
or, 2 : 7 :: 10 men

10

2) 70

35 = the number of men required

to reap 70 acres in 4 days: whence, we have

10 days : 4 days :: 35 men
or, 5 : 2 :: 35 men
or, 1 : 2 :: 7

7

14 men.

(4) 64 men : 48 men :: 16 days
or, 4 : 3 :: 16 days
or, 1 : 3 :: 4

4

12 = the number of days of 9 hours

each, in which 64 men can do the piece of work: hence,

12 hrs. : 9 hrs. :: 12 days
or, 1 : 9 :: 1

1

9 = the number of days of 12 hours

each, in which 64 men can perform the work; so that $9 \times 3 = 27$ days will be the time required.

(5) 13 cwt. 2 qrs. 19 lbs. : 41 cwt. 1 lb. :: £4. 17*s.* 6*d.*
or, 1531 lbs. : 4593 lbs. :: 1170*d.*
or, 1 : 3 :: 1170*d.*
3
3510*d.* = the price of

the conveyance of 41 cwt. 1 lb., for 35 miles; whence, we shall have, for the most obvious reason,

35 mi. : 49 mi. :: 3510*d.*
or, 5 : 7 :: 3510*d.*
or, 1 : 7 :: 702
7
12) 4914*d.*
2,0) 409,6
£20 . 9 . 6 = the charge

for carrying 41 cwt. 1 lb., the distance of 49 miles.

(6) £16 : £24 :: £20
or, 2 : 3 :: £20
or, 1 : 3 :: 10
10
£30 = the sum requisite to gain

£24 in 15 months: therefore we shall now have

3 mo. : 15 mo. :: £30
or, 1 : 15 :: £10
10
£150 = the sum which will gain £24

in 3 months, under the same circumstances.

(7) Since, a *fifth* part of 20 days = 4 days, we have

4 days : 20 days :: 12 men
or, 1 : 5 :: 12 men
12
60 = the number of men that could

perform the proposed work in a *fifth* part of the time: and it follows immediately that for a piece of work *four* times as great, $60 \times 4 = 240$ men will be required.

(8) £1000 : £385 :: £100
or, 2 : 77 :: £1
1
2) 77
£38 . 10*s.* = the sum gained by

a capital of £385 in 7 months: whence,

£38. 10*s.* : £60. 10*s.* :: 7 mo.
or, 770*s.* : 1210*s.* :: 7 mo.
or, 7 : 11 :: 7 mo.
or, 1 : 11 :: 1
1
11 months.

The solution of each of these examples may be conducted by *other* methods, as in the instance given in the text: and by viewing them in different lights, a very comprehensive understanding of the rule may soon be acquired, so as to justify the observation made at the end of Ex. (5) of Article (66): but much *practical* facility will hereafter be afforded to the student by the simple considerations presented to his notice in Article (139) of the Chapter on *Ratio* and *Proportion*.

CHAPTER IV.

VULGAR FRACTIONS.

MISCELLANEOUS QUESTIONS.

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(1) Because $\frac{3}{16}$ of a ticket cost £4. 10*s.*: $\frac{1}{16}$ of it cost £1. 10*s.*: therefore a whole ticket cost £1. 10*s.* $\times 16$ = £24: whence, the price of one fifth of a ticket = $\frac{1}{5}$ of £24 = £4. 16*s.*

(2) Since $\frac{3}{11}$ of $\frac{2}{9}$ of $\frac{4}{17} = \frac{8}{561}$ of the ship was sold for $£12\frac{4}{33} = £\frac{400}{33}$: the price of the ship was

$$= £\frac{400}{33} \times \frac{561}{8} = £850:$$

also, $\frac{2\frac{1}{2}}{4\frac{1}{4}}$ of $\frac{2}{5} = \frac{4}{17}$, the price of which must therefore be $\frac{4}{17}$ of £850 = 4 $\times$ £50 = £200.

(3) Here, $69\frac{1}{2}$ miles = $\frac{139}{2} \times 1760$ yards = 139×880 yards: and because 35 yards = 32 metres, we have 1 yard = $\frac{32}{35}$ metres: whence, the number of metres required will evidently be

$$= 139 \times 880 \times \frac{32}{35} = 139 \times 176 \times \frac{32}{7} = 1118352\frac{4}{7}.$$

(4) Here, $£10\frac{1}{3} = £\frac{31}{3}$ is the duty per cent., and therefore, $£\frac{31}{3} \div 100 = £\frac{31}{300}$ is the duty in the pound:

whence, the duty on £1800. 18*s*. 9*d*. $= \frac{31}{300}$ of £1800. 18*s*. 9*d*. $= \frac{31}{100}$ of £600. 6*s*. 3*d*. = £186. 1*s*. $11\frac{1}{4}d$. = the duty on 5763 bushels: therefore the duty on 1 bushel $= 7\frac{3}{4}d$.

(5) Here, 1 English foot = 12 inches $= \frac{48}{56} = \frac{6}{7}$ of a Cremonese foot: whence, 1 metre $= 39\frac{371}{1000}$ inches

$$= \frac{1}{14} \times 39\frac{371}{1000} = 2\frac{11371}{14000} \text{ Cremonese feet.}$$

(6) Since $\frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \frac{4}{12} + \frac{3}{12} + \frac{2}{12} = \frac{9}{12} = \frac{3}{4}$, we have $\frac{3}{4}$ of the number = 45; whence, $\frac{1}{4}$ of the number is $\frac{45}{3} = 15$, and the number itself $= 15 \times 4 = 60$.

(7) Here, $\frac{5}{9} + \frac{1}{6} = \frac{10}{18} + \frac{3}{18} = \frac{13}{18}$ of his income is expended, and $1 - \frac{13}{18} = \frac{5}{18}$ is the part of his income saved, which is £60: therefore $\frac{1}{18}$ of his income = £12, and the whole income will be £12 × 18 = £216.

(8) The parts detached $= \frac{11}{28} + \frac{2}{7} = \frac{11}{28} + \frac{8}{28} = \frac{19}{28}$, so that $\frac{9}{28}$ of the company remains which is 1350 men: therefore $\frac{1}{28}$ of the company $= \frac{1}{9}$ of 1350 men = 150 men, and the whole company consisted of 28 × 150 men = 4200 men.

(9) Since $\frac{1}{3}$ of the vessel is empty at first, it is evident that the part of it expressed by

$$\frac{2}{3} - \frac{3}{8} = \frac{16-9}{24} = \frac{7}{24}$$

contains 35 gallons; therefore the capacity of the vessel is $\frac{24}{7}$ of 35 gallons = 120 gallons.

(10) First, $\frac{1}{4}+\frac{1}{3}=\frac{7}{12}$, and $1-\frac{7}{12}=\frac{5}{12}$; that is, $\frac{5}{12}$ of the length is 10 feet, and the whole length will therefore be $\frac{12}{5}\times 10$ feet $= 24$ feet.

(11) Since $\frac{11}{20}$ is left to the elder child, $1-\frac{11}{20}=\frac{9}{20}$ is the share of the younger: therefore $\frac{11}{20}-\frac{9}{20}=\frac{2}{20}=\frac{1}{10}$ of the estate is valued at £525, so that its entire value $= 10\times$ £525 $=$ £5250.

(12) Here, $1+\frac{1}{7}=\frac{8}{7}$ of the cargo is worth £17600, and the value of the cargo is therefore $=\frac{7}{8}$ of £17600 $=$ £15400: whence, the value of the ship $=\frac{1}{7}$ of £15400 $=$ £2200.

(13) Since $\frac{1}{5}+\frac{3}{8}=\frac{23}{40}$, we have $1-\frac{23}{40}=\frac{17}{40}$ of the field $=$ 1 ac. 3 ro. 26 po.: therefore the field itself $=\frac{40}{17}$ of 1 ac. 3 ro. 26 po. $=$ 4 ac. 2 ro.; of which $\frac{1}{5}=$ 0 ac. 3 ro. 24 po. is meadow: and $\frac{3}{8}$ of it $=$ 1 ac. 2 ro. 30 po. is arable.

(14) First, $3\frac{7}{11}$ of $10\frac{5}{7}$ of $7\frac{1}{2}$ of $\frac{77}{540}$ of $27s.=\frac{4\times 7}{3\times 11}$ of $\frac{5\times 2}{1\times 7}$ of $\frac{11\times 7}{27\times 20}$ of $27s.=\frac{14}{3}s.$: then $\frac{1}{7}$ of $\frac{3}{4}$ of $\frac{14}{3}s.=\frac{1}{2}s.=6d.$ received by B: whence, C received $\frac{3}{5}$ of the difference of $\frac{14}{3}s.$ and $\frac{1}{2}s.=\frac{3}{5}$ of $\frac{25}{6}s.=\frac{5}{2}s.=2s.\ 6d.$

(15) Here, $2\frac{3\frac{1}{7}}{1\frac{2}{3}}$ of £1. 11*s*. 6*d*. $=\frac{32}{7}$ of £1. 11*s*. 6*d*. $=$ £7. 4*s*., the sum B paid to A, so that A had then £7. 4*s*. + £1. 8*s*. = £8. 12*s*., and $\frac{1}{43}$ of this = 4*s*.: whence, B had at first £7. 4*s*. + 4*s*. = £7. 8*s*.

(16) Here, A can do $\frac{1}{55}$ in 1 hour: and B can do $\frac{1}{66}$ in 1 hour: $\therefore$ A and B together can do $\frac{1}{55}+\frac{1}{66}=\frac{1}{30}$ in 1 hour: and they can do $\frac{10}{30}=\frac{1}{3}$ in 10 hours, or 1 day, and the whole in 3 days.

(17) Here, A and B can do $\frac{1}{18}$ of the work in 1 day: A and C, $\frac{1}{12}$ in 1 day, and B and C, $\frac{1}{9}$ in 1 day: whence, in 2 days, A, B and C together can do $\frac{1}{18}+\frac{1}{12}+\frac{1}{9}=\frac{1}{4}$ of it, so that they can do $\frac{1}{8}$ of it in 1 day, and therefore the whole work in 8 days.

(18) The parts emptied by the two taps in 1 hour are $\frac{1}{4}$ and $\frac{1}{6}$, whose sum $=\frac{5}{12}$: whence, the time of emptying the cask $=\frac{12}{5}$ hrs. = 2 hrs. 24 min.

(19) A, B and C can do $\frac{1}{12}$ of it in 1 hour; also, A and B can do $\frac{1}{16}$ of it, and A and C can do $\frac{1}{18}$ of it, in 1 hour: whence, the part done by B in 1 hour $=\frac{1}{12}-\frac{1}{18}=\frac{1}{36}$: the part done by C in 1 hour $=\frac{1}{12}-\frac{1}{16}=\frac{1}{48}$: therefore B and C in 1 hour can together do $\frac{1}{36}+\frac{1}{48}=\frac{7}{144}$; or, they can do $\frac{7}{144}\times 9\frac{1}{7}=\frac{4}{9}$ of it in $9\frac{1}{7}$ hours.

(20) The parts filled by the two spouts in 1 minute are $\frac{1}{20}$ and $\frac{1}{24}$, and that emptied by the tap in 1 minute is $\frac{1}{30}$, whence, we evidently have $\left\{\frac{1}{20}+\frac{1}{24}-\frac{1}{30}\right\} \times 15$ $= \frac{7}{120} \times 15 = \frac{7}{8}$, the portion required.

(21) Here, $\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}=\frac{19}{20}$, so that $1-\frac{19}{20}=\frac{1}{20}$ of the whole number of trees is 12: whence, that number must be $12 \times 20 = 240$: therefore, of this, $\frac{1}{3}=80$ apple trees, $\frac{1}{4}=60$ pear trees, $\frac{1}{5}=48$ cherry trees, and $\frac{1}{6}=40$ filbert trees.

(22) Since, by paying away $\frac{1}{3}$ of his money, he must evidently have left $£15+£10=£25$ more than $\frac{1}{2}$ of it; it follows that $\frac{2}{3}-\frac{1}{2}=\frac{1}{6}$ of his money must be $£25$, and therefore he had $£25 \times 6 = £150$.

(23) The price of the wheat and barley $= 5 \times \frac{32}{33}$ $\times 60s. + 3 \times \frac{32}{33} \times 54s. = \frac{32}{33}$ of $(300s. + 162s.) = \frac{32}{33}$ of $462s.$ $= 32 \times 14s. = 448s. = £22.\ 8s.$

(24) A can do $\frac{2}{3}$ in 4 hours; therefore A can do $\frac{2}{3} \div 4 = \frac{2}{12} = \frac{1}{6}$ in one hour: B can do $\frac{3}{4}$ of $\frac{1}{3} = \frac{1}{4}$ in one hour: also $\frac{2}{3}+\frac{1}{4}=\frac{11}{12}$, or the remainder $=\frac{1}{12}$; therefore C can do $\frac{1}{12}$ in 20 minutes, or $\frac{3}{12}=\frac{1}{4}$ in one hour; therefore A, B and C can do $\frac{1}{6}+\frac{1}{4}+\frac{1}{4}=\frac{1}{6}+\frac{1}{2}=\frac{2}{3}$ in one

hour: whence $\frac{2}{3} : 1 :: 1 :$ time required; therefore the time required $= 1 \times 1 \div \frac{2}{3} = \frac{3}{2} = 1\frac{1}{2}$ hours.

(25) Here $\frac{1}{3}$ of £10000 = £3333. 6*s*. 8*d*. to his wife: $\frac{1}{2}$ of £10000 = £5000. 0*s*. 0*d*. to his son: and the remainder = £1666. 13*s*. 4*d*. to his daughter. The wife leaves $\frac{3}{5}$ of £3333. 6*s*. 8*d*. = £2000 to the son, $\frac{2}{5}$ of £3333. 6*s*. 8*d*. = £1333. 6*s*. 8*d*. to the daughter; but the son adds his fortune to the daughter's, and gives her $\frac{1}{3}$ of the whole = £3333. 6*s*. 8*d*.: her father and mother together left her £3000; therefore she gains £333. 6*s*. 8*d*. by the transaction.

(26) Here, *C* in 1 day can do $\frac{2}{3}$ of the work which *A* can do in 1 day, and he can do $\frac{5}{4}$ of what *B* can do in the same time: whence, it follows that $\frac{2}{3}$ of *A*'s work in 1 day is equivalent to $\frac{5}{4}$ of *B*'s work in 1 day: or, *B*'s work in 1 day $= \frac{8}{15}$ of *A*'s work in 1 day: whence, the time required will manifestly be $\frac{15}{8}$ of 6 weeks $= \frac{45}{4}$ $= 11\frac{1}{4}$ weeks.

(27) $\frac{1}{3}$ time required $+ \frac{1}{4}$(time required $- 1$) = time required $- 2$: and multiplying by 12, we have 4 time required + 3 time required $- 3 = 12$ time required $- 24$; that is, 5 time required $= 21$: therefore time required $= \frac{21}{5}$ $= 4$ hours, 12 minutes, from 1 o'clock = 12 minutes past 5.

(28) Here, *A* can do the work in 6 hours; therefore *B* can do it in 12 hours: also, *A* and *B* can do $\frac{1}{6} + \frac{1}{21}$

$= \frac{1}{4}$ of the work in 1 hour: and A, B, C can do $\frac{2}{5}$ of it in 1 hour, so that C can do $\frac{2}{5} - \frac{1}{4} = \frac{3}{20}$ in 1 hour: whence, C in 5 hours can do $\frac{3}{4}$ of the work the same as $\frac{1}{12} \times 9 = \frac{9}{12}$, which is what B can do in 9 hours.

In these solutions, the general principles involved in each have been indicated with as much brevity as possible; because it is conceived that when every step in the subjects of a *Science* like *Arithmetic*, is put down at *length*, no scope can be left for the *reasoning* or *inventive* faculties of the student: and for the same reason, the *details* of all the fundamental operations have here been omitted.

CHAPTER VI.

RATIO AND PROPORTION.

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(1) $x : 7 :: 27 : 3$,

or, $x : 7 :: 9 : 1$; whence, $x = 63$.

$39 : x :: 31\frac{1}{4} : 2\frac{3}{5}$,

or, $39 : x :: 5 : 4$; whence, $x = 31\frac{1}{5}$.

(2) $x : 40 :: 3.75 : 3$,

or, $x : 40 :: 375 : 300$,

$:: 5 : 4$; whence, $x = 50$.

$\frac{2}{7} : 17 :: 1.25 : x$,

or, $2 : 119 :: 125 : 100x$,

$:: 5 : 4x$;

whence, $8x = 595$, and $x = 74\frac{3}{8}$.

(3) $\frac{1}{20} : 35 :: x : 3\frac{3}{4}$;

whence, $35x = \frac{1}{20} \times \frac{15}{4} = \frac{3}{16}$, and $x = \frac{3}{560}$.

$.35 : x :: 125 : .0145$,

whence, $125x = .35 \times .0145$, $25x = .07 \times .0145$,

$5x = .07 \times .0029$, and $x = .07 \times .00058 = .0000406$.

(4) Here, $63s. : 66s.\ 6d. :: 4\frac{1}{2}d. : x$,

or, $126 : 133 :: \frac{9}{2}d. : x$;

whence, $x = \frac{133}{126} \times \frac{9}{2}d. = \frac{19}{18} \times \frac{9}{2}d. = \frac{19}{4}d. = 4\frac{3}{4}d.$

(5) Here, $24 \times 10\frac{1}{2} : x \times 12\frac{3}{4} :: 1 : 1$;
whence, $x = 24 \times 10\frac{1}{2} \div 12\frac{3}{4} = 19\frac{13}{17}$ days.

(6) Here, the length $= 160 \div 15 = \frac{32}{3} = 10$ po. 3 yds. 2 ft.

(7) Here, 400×12 : number required $\times 2 :: 5 : 15$; whence, the number required

$$= \frac{400 \times 12 \times 15}{2 \times 5} = 400 \times 18 = 7200 \text{ soldiers.}$$

(8) Here,

$\frac{1}{7}$ of 4*s.* 8*d.* : $\frac{1}{11}$ of 7*s.* $1\frac{1}{4}d.$ :: £3. 7*s.* 8*d.* : x,

or, 8*d.* : $7\frac{3}{4}d.$ :: £3. 7*s.* 8*d.* : x,

or, 32 : 31 :: 812*d.* : x;

whence, $x = \frac{31}{32} \times 812d. =$ £3. 5*s.* $6\frac{1}{2}d.$ $\frac{1}{2}f.$

(9) Here, $4.35 \times 5.75 : 49.3 \times 18.4 :: 6d. : x$,

$$\text{or, } x = \frac{49.3 \times 18.4 \times 6}{4.35 \times 5.75} = \frac{5442.72}{25.0125}$$

$$= \frac{43541.76}{200.1} = 217.6d. = 18.1\dot{3}s.$$

(10) Here, $10.164 \times 4.5 : 8.4 \times x :: 142.2 : 505.6$,

$$\text{or } x = \frac{10.164 \times 4.5 \times 505.6}{8.4 \times 142.2} = \frac{23125.1328}{1194.48} = 19.36 \text{ days.}$$

(11) $$20 \times 12 : x \times \frac{12}{5} :: 1 : 3;$$

whence, $\frac{12}{5}x = 20 \times 12 \times 3$, and $x = 20 \times 12 \times 3 \times \frac{5}{12} = 300$ men.

(12) $12 \times 10 : x \times 4 :: 300 \times 300 : 600 \times 10,$

or, $3 : x :: 3 : 2$; whence, $x = 2$ men.

(13) $3 \times 10 \times 5 : x \times 12 \times 2 :: 150 \times 240 : 192 \times 300,$

or, $: 24x :: 240 : 192 \times 300$

$:: 20 : 16 \times 300$

$:: 1 : 16 \times 15;$

$\therefore 24x = 240; \quad \therefore x = 10$ men.

(14) $7 \times 35 \times 12 : 12 \times 43 \times 10 :: 245 \times 8 \times 1\frac{1}{2}$

$: x \times 10 \times 2\frac{1}{4};$

whence, we find $x = 229$ yds. 1 ft.

(15) $27 \times 14 \times 10 : \frac{1}{2}$ of $24 \times 45 \times x :: 1 : 1;$

whence, $x = \dfrac{27 \times 14 \times 10}{12 \times 45} = 7$ hours.

(16) Since, $21216 \div 26 = 816$ shots to be fired from each gun, when there are 4 men to a gun, we have

$48 : 816 :: 1 : 17$ hours;

and when there are 5 men to a gun, we have

$52 : 816 :: 1 : 15\frac{9}{13}$ hours;

whence, the excess $= 17 - 15\frac{9}{13} = 1\frac{4}{13}$ hours.

(17) Since $\frac{3}{5}$ and $\frac{5}{6}$ denote the *numbers* of rounds in 1 minute respectively, we have

$$10 \times \frac{3}{5} \times 1\frac{1}{2} : x \times \frac{5}{6} \times 1 :: 270 : 500;$$

whence, $x = \dfrac{500}{270} \times 10 \times \dfrac{3}{5} \times \dfrac{3}{2} \times \dfrac{6}{5} = 20$ cannon.

(18) $120 \times 3 \times 12 : x \times 9 \times 15 :: 90 \times 2 \times 4 : 150 \times 6 \times 4\frac{1}{2};$ whence, $x = 180$ men.

(19) Since $6 \times 3 \times 14 = 252$, and $10 \times 5 \times 9 = 450$, we have $252 \times x : 450 \times 1 :: 15 : 10\frac{5}{7};$

whence, $x = \frac{5}{2}$ the ratio of the work of a man to that of a boy.

Also, 1 man reaps 15 acres in 18 days: therefore 1 man reaps $\frac{5}{6}$ acres in 1 day: and 1 boy reaps $\frac{75}{7} \div 50 = \frac{3}{14}$ acres in 1 day: whence, 4 men and 7 boys reap in 1 day

$$4 \times \frac{5}{6} + 7 \times \frac{3}{14} = 3\tfrac{1}{3} + 1\tfrac{1}{2} = 4\tfrac{5}{6} \text{ acres.}$$

(20) The number of hours from 12 o'clock on Monday to a quarter past 10 on the Saturday morning, is $118\frac{1}{4}$: whence, we have

$$24 : 118\tfrac{1}{4} :: 3 \text{ min. } 10 \text{ sec. } : x;$$

or, the gain in the proposed time $= 15$ min. $36\frac{7}{48}$ sec.: therefore, the time required will be

15 min. + 10 min. + 15 min. + $36\frac{7}{48}$ sec. = 40 min. $36\frac{7}{48}$ sec. past ten.

(21) The number of hours from the noon of Tuesday to 6 o'clock on Friday morning being 66, and 10 min. + $7\frac{1}{2}$ min. = $17\frac{1}{2}$ minutes being the *separation* in 24 hours, we have,

$$24 : 66 :: 17\tfrac{1}{2} : x;$$

which gives $x = 48$ min. $7\frac{1}{2}$ sec., the *difference* required.

(22) Here, $3 \times 62s.\ 8d. : 5 \times 50s. :: 1s.\ 3d. : x$; whence, $x = 1s.\ 7\frac{3}{4}d. \frac{37}{47}f.$, the price required.

SIMPLE INTEREST.

PAGE 135.

All these examples are solved by the *immediate* application of the Rule: but many useful abbreviations of the processes will soon be learned by a little practice. The observation contained in Article (143), will now be briefly illustrated by means of Ex. (3) of this set, in the following Questions.

(1) If £325. 16*s*. 8*d*. in $3\frac{1}{2}$ years, amount to £374. 6*s*. $0\frac{1}{4}d$.: what is the rate per cent. per annum?

Here, the interest in $3\frac{1}{2}$ years = £48. 19*s*. $4\frac{1}{4}d$.:

therefore, the interest in 1 year = £13. 19*s*. $9\frac{1}{7}d$. $\frac{1}{7}f$.:

whence, £325. 16*s*. 8*d*. : £100 :: £13. 19*s*. $9\frac{1}{7}d$. $\frac{1}{7}f$. : x;

and x = £4. 5*s*. = $4\frac{1}{4}$, the rate per cent. per annum.

(2) If £325. 16*s*. 8*d*. at $4\frac{1}{4}$ per cent. per annum, amount to £374. 6*s*. $0\frac{1}{4}d$.: find the number of years.

Here, £48. 19*s*. $4\frac{1}{4}d$. is the interest of £325. 16*s*. 8*d*., when the interest of £100 for 1 year is £4. 5*s*.: whence, we have

£100 × 1 : £325. 16*s*. 8*d*. × x :: £4. 5*s*. : £48. 19*s*. $4\frac{1}{4}d$.;

which gives $x = 3\frac{1}{2}$ years.

(3) The amount of a certain sum in $3\frac{1}{2}$ years at $4\frac{1}{4}$ per cent. per annum, is £374. 6*s*. $0\frac{1}{4}d$.: what is the sum?

At $4\frac{1}{4}$ per cent. per annum, £100 in $3\frac{1}{2}$ years amounts to £114. 17*s*. 6*d*.: whence, we have

£114. 17*s*. 6*d*. : £374. 6*s*. $0\frac{1}{4}d$. :: 100 : x;

and therefore, x = £325. 16*s*. 8*d*.

(4) Find the sum whose simple interest at $4\frac{1}{4}$ per cent. per annum, amounts in $3\frac{1}{2}$ years, to £48. 19*s*. $4\frac{1}{4}d$.

Here, £14. 17*s*. 6*d*. : £48. 19*s*. $4\frac{1}{4}d$. :: 100 : x;

from which, x = £325. 16*s*. 8*d*.

In these four instances, are included *directly* or *indirectly*, all the varieties that can occur; and for the sake of acquiring a *readiness* in questions of this kind, it may be desirable for the student to diversify some of the *other* examples given under this head, in the same way as we have just done.

COMPOUND INTEREST.

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Merely for the sake of explaining what is meant by the remark made at the *end* of these examples, we shall give the solutions of those numbered (4), (5) and (6).

(4) The rate of 5 per *cent.* $= \frac{5}{100} = \frac{1}{20}$ in the pound; whence, we have

	£.	s.	d.	
20)	725 .	0 .	0	
	36 .	5 .	0	
20)	761 .	5 .	0	= amount in 1 year:
	38 .	1 .	3	
20)	799 .	6 .	3	= amount in 2 years:
	39 .	19 .	$3\frac{3}{4}$	
20)	839 .	5 .	$6\frac{3}{4}$	= amount in 3 years:
	41 .	19 .	$3\frac{27}{80}$	
	£881 .	4 .	$10\frac{7}{80}$	= amount in 4 years.

(5) Since 2 per cent. for a *half year* $= £\frac{1}{50}$, we have

	£.		
50)	550 .	5	
	11 .	01	
50)	561 .	51	= amount in ½ year:
	11 .	2302	
50)	572 .	7402	= amount in 1 year:
	11 .	454804	
	£584 .	195004	= amount in 1½ years:
		20	
	s. 3 .	900080	
		12	
	d. 10 .	800960	
		4	
	f. 3 .	203840	

(6) Since £12. 10*s.* = $\frac{1}{8}$ of £100, we have

£.	*s.*	*d.*	
8) 819 .	4 .	0	
102 .	8 .	0	
8) 921 .	12 .	0	= amount in 1 year:
115 .	4 .	0	
8) 1036 .	16 .	0	= amount in 2 years:
129 .	12 .	0	
8) 1166 .	8 .	0	= amount in 3 years:
145 .	16 .	0	
8) 1312 .	4 .	0	= amount in 4 years:
164 .	0 .	6	
8) 1476 .	4 .	6	= amount in 5 years:
184 .	10 .	$6\frac{3}{4}$	
£1660 .	15 .	$0\frac{3}{4}$	= amount in 6 years:

whence, £1660. 15*s.* $0\frac{3}{4}$*d.* − £819. 4*s.* = £841. 11*s.* $0\frac{3}{4}$*d.* is the compound interest for 6 years.

TRANSFERS OF STOCKS.

PAGE 143.

The solutions of Examples (1)—(6) are omitted, as being merely repetitions of the operations exhibited in the text: but the following explain some peculiarities.

(7) The price of £100 stock is in this case = $90\frac{3}{8} + \frac{1}{8}$ = £$90\frac{1}{2}$ sterling; whence, we have

£650
$90\frac{1}{2}$
58500
325
£588 . 25
20
s. 5 . 00

and the cost is therefore £588. 5*s.* sterling.

(8) For £100 stock there is received $90\frac{3}{8} - \frac{1}{8} = £90\frac{1}{4}$ sterling; whence, we have

£.	s.	d.	
1760	16	8	
			$10 \times 9 + \frac{1}{4} = 90\frac{1}{4}$
17608	6	8	
		9	
158475	0	0	
440	4	2	
£1589	15	4	2
	20		
s. 3	04		
	12		
d. 0	50		
	4		
f. 2	00		

and therefore the sterling money received is £1589. 3*s.* $0\frac{1}{2}d.$

(9) Here, $£76\frac{1}{2} : £650 :: 100 : x$;

whence, $\frac{153}{2}x = 65000$; or, $x = \frac{130000}{153}$

is the *quantity* of stock purchased: and the *value* of this stock sold at $77\frac{31}{40}$ will therefore be

$$£\frac{3111}{4000} \times \frac{130000}{153} = £\frac{1037}{4} \times \frac{130}{51} = £\frac{1037}{2} \times \frac{65}{51}$$

$$= £\frac{61}{2} \times \frac{65}{3} = £660.\ 16s.\ 8d.;$$

so that the gain = £660. 16*s.* 8*d.* − £650 = £10. 16*s.* 8*d.*

(10) The price of the stock sold out will manifestly be $\frac{65}{100} \times £10000 = £6500$: and its investment in the 4 per cents. at $82\frac{1}{2}$ gives a *quantity* of stock

$$= \frac{100}{82\frac{1}{2}} \times £6500 = £\frac{1300000}{165} = £\frac{260000}{33}:$$

whence, the *original* income being $£10000 \times \frac{3}{100} = £300$, and the *new* income being $£\frac{260000}{33} \times \frac{4}{100} = 315.\ 3s.\ 0\frac{4}{11}d.$, it follows that the *excess* of the latter of these above the former, or $£15.\ 3s.\ 0\frac{4}{11}d.$ is the *increase* in his income.

(11) Here, $£97\frac{1}{2} : £879 :: 100 : x$, gives $x = £\frac{40}{13} \times 271$, the *quantity* of stock in the original investment at $97\frac{1}{2}$:

$$\text{whence, } \frac{40}{13} \times 271 \times 97\tfrac{1}{2} : x \times 88\tfrac{1}{4} :: 1 : 1;$$

$$\text{and } x = \frac{40}{13} \times 271 \times \frac{195}{2} \div \frac{353}{4} = £996\tfrac{12}{353}.$$

(12) Since the dividend in 1 year $= \frac{1}{13}$ of $£3081 = £237$, we have $£3 : £237 :: 100 : x$; from which we find

$$x = \frac{237}{3} \times £100 = 79 \times £100 = £7900,$$

the *quantity* of stock:

$$\text{and } £100 : £7900 :: 79\tfrac{7}{8} : x,$$

$$\text{or, } 1 : 79 :: 639 : 8x;$$

whence, $x = \frac{79}{8} \times £639 = £6310\frac{1}{8}$, is the sterling worth of the stock at the proposed rate.

Attention to the solutions here given, will soon render the student an adept in calculations of this description: and with the exercise of a little judgment, the questions may easily be varied so as to make him perfectly conversant with the *Theory* of the *Stock Exchange.*

DISCOUNT OR REBATE.

PAGE 147.

Examples (1)—(6) are omitted for reasons given before.

(7) £4 . 10*s.* = interest of £100 for 1 year:
2 . 5*s.* = interest of £100 for ½ year:
6 . 15 = interest of £100 for 1½ years:
100
£106 . 15*s.* = amount of £100 in 1½ years:

whence, £106. 15*s.* : £275. 6*s.* 8*d.* :: £100 : *x*,

which gives $x = £257.\ 18s.\ 5\frac{1}{2}d.\ \frac{34}{61}f.$ the sum required.

(8) The amount of £100 in 146 days at 4½ per cent. per annum $= £100 + \frac{146}{365}$ of £4½ = £100 + ⅖ of £4½ = £101 11/15: also, £241. 12*s.* 4*d.* = £241 37/60:

whence, £101 11/15 : £241 37/60 :: £100 : *x*;

and therefore, $x = £237\frac{1}{2} = £237.\ 10s.$ is the present worth.

(9) The present worth of £715. 17*s.* due 9 months hence, at 4 per cent. per annum simple interest, is found from

£103 : £715. 17*s.* :: £100 : *x*,

which gives *x* = £695: whence, we have

£92⅔ : £695 :: £100 : *x*;

and therefore, *x* = £750, the quantity of stock required.

(10) If *x* be the present value of £100, payable at the end of 6 months, allowing 5 per cent. per annum simple interest, we have

£102½ : £100 :: £100 : *x*,

which gives $x = \frac{10000}{102\frac{1}{2}} = \frac{20000}{205}$:

and therefore the fixed ratio of the prices ought to be

$$\frac{20000}{205} : 100, \text{ or } \frac{200}{205} : 1, \quad \text{or } \frac{40}{41} : 1,$$

which is the same as 40 : 41.

(11) Here, 103 : 100 :: £2652.5 : sum due 2 years hence; or, sum due 2 years hence

$$= \frac{100 \times £2652.5s.}{103} = £2575;$$

again, 103 : 100 :: £2575 : sum due 1 year hence;

$$\text{or, sum due 1 year hence} = \frac{2575 \times 100}{103} = £2500.$$

(12) Here, 105 : 100 :: £9724.1*s.* : sum due 3 years hence; or, sum due 3 years hence

$$= \frac{100}{105} \times £9724.1s. = \frac{20}{21} \text{ of } £9724.1s. = £9261;$$

$$\text{again, sum due 2 years hence} = \frac{20}{21} \times 9261 = £8820;$$

$$\text{also, sum due 1 year hence} = \frac{20}{21} \times 8820 = £8400;$$

$$\text{and sum due now} = \frac{20}{21} \times 8400 = £8000.$$

MISCELLANEOUS QUESTIONS.

PAGE 161.

(1) 1 cwt. : 3 cwt. 3 qrs. :: £3. 4*s.* : x;

whence, $x = £12$, the value of the sugar:

also, 14*s.* 6*d.* : £12 :: 1 yd. : x,

which gives $x = 16$ yds. $2\frac{8}{29}$ qrs.

(2) 1 gal. : 3 hhds. :: 6*s.* 8*d.* : x,

or, the price of the brandy is £63 = the price of 126 yards of cloth: therefore, the price of 1 yard = $\frac{1}{126}$ of £63 = 10*s.*

(3) £100 : £115 :: £3. 16*s*. 8*d*. : *x*,

so that the retail price per *cwt*., or $x = \frac{23}{20}$ of £3. 16*s*. 8*d*.: and therefore the retail price per *pound* will be $\frac{1}{112}$ of $\frac{23}{20}$ of £3. 16*s*. 8*d*. = $9\frac{1}{4}d.\ \frac{11}{14}f.$

(4) 94 : 100 :: 6*s*. 4*d*. : *x*,

and $x = 6s.\ 8\frac{3}{4}d.\ \frac{19}{4}f.$ is the prime cost of 1 lb.

(5) The prime cost including the expences = £122. 10*s*.: and the retail price must therefore be

$$£122.\ 10s. + \frac{50}{100} \text{ of } £122.\ 10s. = £183.\ 15s.:$$

whence, 2 tons 3 cwt. 3 qrs. : 1 cwt. :: £183. 15*s*. : *x*, which gives *x* = £4. 4*s*., the retail price per cwt.

(6) 91 : 107 :: £182 : £214, the required price.

(7) Here, $300 \times 66 = 19800d. = 1650s.$,
$100 \times 24 = 2400d. = 200s.$,
therefore price he sells for = 1850*s*. = £92. 10*s*.; therefore he gains £92. 10*s*. − £80 = £12. 10*s*. on £80; then, 80 : 100 :: £12. 10*s*. : required gain; or, required gain $= \frac{5}{4} \times$ £12. 10*s*. = £15. 12*s*. 6*d*.

(8) Since $\frac{3}{8}$ of 11*s*. = $4\frac{1}{8}s.$, the prime cost per thousand = 11*s*. − $4\frac{1}{8}s. = 6\frac{7}{8}s.$: whence, $6\frac{7}{8}s.$: $13\frac{1}{2}s.$ :: £100 : *x*; and therefore, $x = \frac{108}{55}$ of £100 = £196. 7*s*. $3\frac{1}{4}d.\ \frac{1}{11}f.$ is the *increased* value of £100, so that the gain per cent. = £96. 7*s*. $3\frac{1}{4}d.\ \frac{1}{11}f.$

(9) 100 : 121 :: £14. 5*s*. : *x*; whence, *x* = £17. 4*s*. $10\frac{1}{8}d.$ is the price per cwt.: also, we have

$$£17.\ 4s.\ 10\tfrac{1}{8}d. - £14.\ 5s. = £2.\ 19s.\ 10\tfrac{1}{8}d.$$

= the gain per cwt.; so that

$$£2.\ 19s.\ 10\tfrac{1}{2}d.\ :\ £100\ ::\ 1\text{ cwt.}\ :\ x;$$

or, $x = 33$ cwt. 1 qr. 18 lbs. $11\frac{7}{171}$ oz. is the quantity required.

(10) Here, the gain on 1 qr. being $17s.\ 1d.$, we have

$$1\text{ qr.}\ :\ 160\text{ qrs.}\ ::\ 17s.\ 1d.\ :\ x;$$

whence, $x = £136.\ 13s.\ 4d.$ is the gain on the whole.

Also, the prime cost of 160 quarters being $£330$, and the retail price of the same being $£416.\ 13s.\ 4d.$, we have

$$£330\ :\ £416.\ 13s.\ 4d.\ ::\ 41s.\ 3d.\ :\ x,$$

which gives $x = 45s.\ 4\frac{1}{2}d.$, the price per quarter.

(11) Here, 30 gallons sell for $£25 + £2.\ 10s. = £27.\ 10s.$; $\therefore$ sale price of 1 gallon $= £27.\ 10s. \div 30 = 18s.\ 4d.$

(12) If A have 1, B must have $\frac{1}{3}$, and therefore C must have $\frac{1}{3}$ of $\left(1 + \frac{1}{3}\right) = \frac{4}{9}$: whence, taking the *least whole numbers* having the same proportions, we have 9, 3 and 4 to represent the shares of A, B and C: therefore, since $9 + 3 + 4 = 16$,

$$16\ :\ 9\ ::\ £64\ :\ £36 = A\text{'s share:}$$

$$16\ :\ 3\ ::\ £64\ :\ £12 = B\text{'s share:}$$

$$16\ :\ 4\ ::\ £64\ :\ £16 = C\text{'s share.}$$

(13) $90\ :\ 100\ ::\ £1250\ :\ x$; and this gives

$x = £1388.\ 17s.\ 9\frac{1}{4}d.\ \frac{1}{8}f.$ his original income.

(14) Here, $107\frac{1}{2}\ :\ 100\ ::\ 9s.\ :\ x$; that is, x or the prime cost per lb. $= \frac{1800}{215}s. = \frac{360}{43}s.$: and therefore the prime cost of the original quantity, or of 150 lbs.

$$= \frac{54000}{43}s.$$

Also, when 10 per cent. is cleared upon the whole quantity, the retail price must be $\frac{110 \times 54000}{100 \times 43} = \frac{59400}{43}s.$:

whence, $\frac{59400}{43}s. - (9s. \times 50) = \frac{40050}{43}s.$

= the retail price of 100 lbs., so that the retail price of 1 lb.

$$= \frac{40050}{4300}s. = \frac{4005}{430}s. = 9s.\ 3\tfrac{3}{4}d.\ \tfrac{3}{43}f.$$

(15) $1 : \frac{1}{8} :: 32 : 256$, which is the number of measures of *mixture* containing $\frac{1}{8}$ of a measure of *wine*; whence, the quantity of water to be *added*

$$= 256 - 32 = 224 \text{ gallons.}$$

(16) The greyhound gains 8 miles in 1 hour: and the distance run by the hare in 40 seconds, before the starting of the greyhound,

$$\text{being } \frac{40}{60 \times 60} \times 17600 \text{ yds.} = \frac{1760}{9} \text{ yds.,}$$

the whole distance to be gained by the greyhound will be

$$\frac{1760}{9} + 40 = \frac{2120}{9} \text{ yds.:}$$

$$\text{whence, } 1760 \times 8 : \frac{2120}{9} :: 3600 \text{ sec.} : x,$$

$$\text{which gives } x = 60\tfrac{5}{22} \text{ seconds;}$$

$$\text{also, } 3600 \text{ sec.} : (40 + 60\tfrac{5}{22}) \text{ sec.} :: 17600 \text{ yds.} : x;$$

and therefore, $x = 490$ yds., the distance run by the hare.

(17) Since the rates of the hour and minute hands are as 1 : 12, it follows the rate of the hour hand to the *difference* of their rates is 1 : 11; and the *separation* of the two hands being 30 minutes in this question, we have

$$1 : 11 :: x : 30; \text{ or, } x = \frac{30}{11} = 2 \text{ min. } 43\tfrac{7}{11} \text{ sec.:}$$

so that the time required

$= 30$ min. $+ 2$ min. $43\frac{7}{11}$ sec. $= 32$ min. $43\frac{7}{11}$ sec. past 12.

(18) Here, $24 + 24 + 12 = 60$ hours, the time in which 3 minutes are gained. Also, from Tuesday at noon to 4 o'clock on Thursday afternoon $= 52$ hours; $\therefore$ whole time $= 60 + 52 = 112$ hours; then $60 : 112 :: 3$: gain required; or, gain required $= \frac{336}{60} = 5\frac{3}{5}$ minutes; or, proper time $= 5\frac{3}{5}$ minutes before 4.

(19) If the work be denoted by *unity*, one man can do $\frac{1}{5 \times 35} = \frac{1}{175}$ in one day: and one woman can do $\frac{1}{7 \times 35} = \frac{1}{245}$ in one day: whence, 7 men and 5 women in 1 day can do

$$\frac{7}{175} + \frac{5}{245} = \frac{1}{25} + \frac{1}{49} = \frac{74}{25 \times 49};$$

$$\text{therefore, } \frac{74}{25 \times 49} : 1 :: 1 \text{ day} : x;$$

and $x = \frac{25 \times 49}{74} = 16\frac{1}{74}$ days, is the time required.

(20) Here, first set do $\frac{4}{3}$ in 1 hour; second set do $\frac{8}{5}$ in 1 hour; therefore both sets do $\frac{4}{3} + \frac{8}{5} = \frac{44}{15}$ in 1 hour: then, 1 : time required $:: \frac{44}{15} : 11$; or, time required $= 11 \div \frac{44}{15} = \frac{165}{44} = \frac{15}{4} = 3\frac{3}{4}$ hours.

(21) Here, $15 \times 3 + 12 \times 2 + 9 \times 1 = 78$, and $9 \times 3 + 15 \times 2 + 18 \times 1 = 75$: whence, we have

$$1 : 2 :: 78 \times 50 : 75 \times x;$$

and this gives $x = \frac{78 \times 100}{75} = 78 \times \frac{4}{3} = 104$ days.

(22) Here, A can do $\frac{1}{5}$ in 1 day: B can do $\frac{2}{7}$ in 1 day, and C can do $\frac{4}{11}$ in 1 day; therefore, A, B and C can do

$$\frac{1}{5}+\frac{2}{7}+\frac{4}{11}=\frac{327}{385}\text{ in 1 day:}$$

whence, we have $\frac{327}{385} : 3 :: 1 : x$;

and therefore, $x=\frac{1155}{327}=\frac{385}{109}=3$ days 12 hrs. $46\frac{36}{109}$ min.

(23) Since A and B can build $\frac{1}{18}$ in 1 day, and A, B and C can build $\frac{1}{11}$ in 1 day; it follows that C can build $\frac{1}{11}-\frac{1}{18}=\frac{7}{198}$ in 1 day; therefore, $\frac{7}{198} : 1 :: 1$ day $: x$;

whence, $x=\frac{198}{7}=28\frac{2}{7}$ days.

(24) A, B, C and D in 1 hour can do respectively 1, $\frac{1}{3}$, $\frac{1}{5}$ and $\frac{1}{7}$, whose sum $=\frac{176}{105}$: whence, we have

$$\frac{176}{105} : 11 :: 1 \text{ hr.} : x,$$

which gives $x=\frac{1155}{176}$ hrs. $=6$ hrs. 33 min. 45 sec.

(25) A and B can do $\frac{1}{10}$ in 1 day: A and C can do $\frac{1}{12}$ in 1 day, and B and C can do $\frac{1}{14}$ in 1 day: whence, by *addition*, it appears that A, B and C in 2 days can do

$$\frac{1}{10}+\frac{1}{12}+\frac{1}{14}=\frac{107}{420}:$$

therefore, in 1 day they can jointly do $\frac{107}{840}$, so that

$$\frac{107}{840} : 1 :: 1 \text{ day} : x; \text{ or, } x = \frac{840}{107} = 7\tfrac{91}{107} \text{ days.}$$

Also, because A, B, C can do $\frac{107}{840}$ in 1 day, and B, C can do $\frac{1}{14}$ in 1 day, A can do $\frac{107}{840} - \frac{1}{14} = \frac{47}{840}$ in 1 day: whence,

$$\frac{47}{840} : 1 :: 1 \text{ day} : x;$$

and therefore, $x = \frac{840}{47} = 17\frac{41}{47}$ days $= A$'s time:

$$B \text{ can do } \frac{107}{840} - \frac{1}{12} = \frac{37}{840} \text{ in 1 day:}$$

$$\text{whence, } \frac{37}{840} : 1 :: 1 \text{ day} : x,$$

$$\text{which gives } x = \frac{840}{37} = 22\tfrac{26}{37} \text{ days} = B\text{'s time:}$$

$$C \text{ can do } \frac{107}{840} - \frac{1}{10} = \frac{23}{840} \text{ in 1 day:}$$

$$\text{so that } \frac{23}{840} : 1 :: 1 \text{ day} : x;$$

and hence we have $x = \frac{840}{23} = 36\frac{12}{23}$ days $= C$'s time.

(26) A, B, C can reap $\frac{1}{18}$ of the field in 1 day: B, C, D, $\frac{1}{20}$; C, D, A, $\frac{1}{24}$, and D, A, B, $\frac{1}{27}$: and in the *sum* of these, each of the agents A, B, C, D occurring *three* times, it follows that A, B, C, D *together* in 1 day can reap

$\frac{1}{3}$ of $\left(\frac{1}{18}+\frac{1}{20}+\frac{1}{24}+\frac{1}{27}\right)=\frac{199}{3240}$ of the field:

whence, we have $\frac{199}{3240}$: 1 :: 1 day : $16\frac{56}{199}$ days, the time in which the field can be reaped by them all together:

$$\text{also, } \frac{199}{3240}-\frac{1}{20}=\frac{37}{3240}$$

is the part reaped by A in 1 day; or, A can reap the field in $\frac{3240}{37}$ days $=87\frac{21}{37}$ days: $\frac{199}{3240}-\frac{1}{24}=\frac{8}{405}$ is the part reaped by B in 1 day: or, B can reap the field in $\frac{405}{8}$ days $=50\frac{5}{8}$ days: $\frac{199}{3240}-\frac{1}{27}=\frac{79}{3240}$ is the part reaped by C in 1 day; or, C can reap the field in $\frac{3240}{79}=41\frac{1}{79}$ days: $\frac{199}{3240}-\frac{1}{18}=\frac{19}{3240}$ is the part reaped by D in 1 day; or, D can reap the field in $\frac{3240}{19}$ days $=170\frac{10}{19}$ days.

CHAPTER IX.

THE APPLICATION OF ARITHMETIC TO GEOMETRY.

THE PRACTICE OF LINEAL MEASURE.

PAGE 204.

(1) HERE, the square of the hypothenuse

$$= 24^2 + 32^2 = 576 + 1024 = 1600:$$

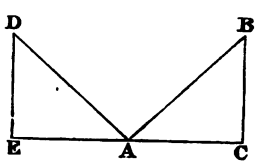
whence, the hypothenuse $= \sqrt{1600} = 40$ feet.

(2) Here, the square of the diameter $= .2^2 + .99^2 = .04 + .9801 = 1.0201$, and $x = \sqrt{1.0201} = 1.01$ in.

(3) The square of the base = the square of $\sqrt{48}$ – the square of $4 = 48 - 16 = 32$: therefore, the base

$$= \sqrt{32} = \sqrt{16 \times 2} = \sqrt{16} \times \sqrt{2} = 4 \times \sqrt{2} = 4\sqrt{2}.$$

(4) In the annexed diagram, where EC is the breadth of the street, and $AB = AD$ = the length of the ladder, we have



$$EC = AE + AC = \sqrt{(103.44)^2 - (40)^2} + \sqrt{(103.44)^2 - (60)^2}$$

$$= \sqrt{10699.8336 - 1600} + \sqrt{10699.8336 - 3600}$$

$$= \sqrt{9099.8336} + \sqrt{7099.8336}$$

$$= 95.393 \text{ &c.} + 84.260 \text{ &c.} = 179.653 \text{ &c.}$$

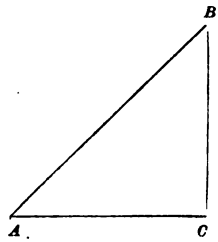
= 180 feet, nearly.

(5) Their distance $= \sqrt{(50)^2 + (84)^2}$

$$= \sqrt{2500 + 7056} = \sqrt{9556} = 97.754 \text{ &c.}$$

$= 97\frac{3}{4}$ leagues, nearly.

(6) In the diagram here inserted, we have



$AB^2 = AC^2 + BC^2 = AC^2 \times 2$: whence, the square of the side is equal to half of the square of the diagonal $= \frac{1}{2}$ of $(125)^2 = \frac{1}{2}$ of $15625 \div 7812.5$: and therefore, the length of the side $= \sqrt{7812.5} = 88.3883$ yards, nearly.

(7) The circumference
$= 2 \times 6.3662 \times 3.14159 = 39.999980516$
$= 40$ yards, nearly.

(8) The circumference of the earth
$= 7912 \times 3.14159 = 24856.26$ miles, nearly,
$= 43747017.6$ yards, nearly,
$= 131241052.8$ feet, nearly,
$= 1574892633.6$ inches, nearly:

whence, a fourth part of its circumference $= 393723158.4$ inches, whereof one ten-millionth part $= 39.37231584$ inches will be the length of a *French Metre*, nearly.

(9) By reduction of the fractions to decimals, we have

$$\frac{22}{7} = 3.142857 \text{ &c.:}$$

$$\frac{333}{106} = 3.141509 \text{ &c.:}$$

$$\frac{355}{113} = 3.141592 \text{ &c.}$$

whence the first $\frac{22}{7}$, said to be due to *Archimedes*, a celebrated ancient Mathematician of *Syracuse*, is correct

only to *two* places of decimals, but the facility of its application is a great recommendation of its use, when much nicety is not required: the second $\frac{333}{106}$ is true to *four* places of decimals; and the last $\frac{355}{113}$, which is easily remembered, and was discovered by *Metius*, a Geometrician of the *Netherlands*, who lived about the end of the *sixteenth* century, appears on comparison with 3.14159, which has been used in the rules, to be correct to the *last* place of decimals, and in fact it is quite accurate to *six* places of decimals, being = 3.14159292 &c., instead of 3.14159265 &c., and therefore somewhat in excess.

As the ratio of the circumference of a circle to its diameter has not yet been expressed in the form of a *commensurable quantity*, all computations depending upon it must necessarily be only *approximations*.

THE PRACTICE OF SUPERFICIAL MEASURE.

PAGE 207.

(1) Half the sum of the sides = $\frac{1}{2}$ of 16.6 + 18.32 + 28.6 = 31.76, and therefore the three remainders are 15.16, 13.44, and 3.16: whence, the area

$$= \sqrt{31.76 \times 15.16 \times 13.44 \times 3.16}$$

$$= \sqrt{20448.71614464} = 142.9997 \text{ &c.}$$

$$= 143, \text{ nearly.}$$

(2) The sum of the perpendiculars

$= 10.8 + 18.8 = 29.6$: whence, the area

$= \frac{1}{2}$ of $498 \times 29.6 = 249 \times 29.6 = 7370.4$ yards.

(3) Since the hexagon consists of six equal triangles whose bases are 24 feet, and whose altitudes are $12\sqrt{3}$ feet, we have the area

$$= 6 \times \tfrac{1}{2} \text{ of } 24 \times 12\sqrt{3} = 864\sqrt{3} \text{ feet.}$$

(4) The square root of $4970.25 = 70.5$ inches: and the square root of $885\frac{1}{16} = 29\frac{3}{4}$ feet.

(5) Here, $2\frac{1}{4} \times x = 1$ square yard $= 9$ square feet:

whence, $x = 9 \div 2\frac{1}{4} = 4$ feet.

(6) Since 1 acre $= 4840$ square yards, we have the square of the radius $\times\ 3.14159 = 4840 \times 2 = 9680$ square yards; whence, the square of the radius $= \frac{9680}{3.14159}$ $= 3081.2423$ &c.: and therefore, the radius required

$= \sqrt{3081.2423} = 55.50$ &c. $= 55\frac{1}{2}$ yards, nearly.

(7) The area of the square $= (5.317)^2$ square yards: whence, the square of the radius of the circle

$$= \frac{(5.317)^2}{3.14159} = \frac{28.270489}{3.14159} = 8.9987 \text{ \&c.};$$

and the radius $= \sqrt{8.9987}$ &c. $= 2.99$ &c. $= 3$ yards, nearly.

(8) Since the area of the ellipse $= 25 \times 49 \times 3.14159$, we have the square of the radius of the circle

$$= \frac{25 \times 49 \times 3.14159}{3.14159} = 25 \times 49:$$

or, the radius required

$$= \sqrt{25 \times 49} = \sqrt{25} \times \sqrt{49} = 5 \times 7 = 35.$$

(9) Since the area of a triangle $= \frac{1}{2}$ the product of the base and perpendicular height, it follows that the perpendicular height is always $=$ to twice the area divided by the base: and here it is therefore

$$= \frac{2 \times 64.86}{14.1} = 9.2 \text{ yards.}$$

(10) Since the semi-sum of the sides is 9, and each of the remainders is 3, we have the area

$$= \sqrt{9 \times 3 \times 3 \times 3} = \sqrt{243} = 15.588, \text{ nearly.}$$

(11) The semi-sum of the sides is 16: whence, the remainders are 8, 4, and 4, so that the area

$$= \sqrt{16 \times 8 \times 4 \times 4}$$

$$= \sqrt{16 \times 8 \times 16} = 4 \times 4 \times \sqrt{4 \times 2}$$

$$= 4 \times 4 \times 2 \times \sqrt{2} = 32\sqrt{2} = 45.2548 \text{ feet, nearly.}$$

(12) If the radius of the circle be 1, its area will be 3.14159: also, the side of the inscribed square being $\sqrt{1^2 + 1^2} = \sqrt{2}$, its area will be $(\sqrt{2})^2 = 2$: whence, the area of a circle : the area of the square inscribed in it :: 3.14159 : 2, nearly.

(13) If the radius of the circle be 1, its area = 3.14159, and the area of the square = the square of the diameter = $2^2 = 4$; whence, the area of a square : the area of the circle inscribed in it :: 4 : 3.14159, nearly.

(14) The area of the sector, being half the product of the radius and the subtending arc, is

$$\tfrac{1}{2} \text{ of } 2.57 \times 2.57 = 3.30245 \text{ inches.}$$

(15) The area of the exterior circle being 144×3.14159, and that of the interior being 100×3.14159, it follows that their difference, or the space included between them,

$$= 144 \times 3.14159 - 100 \times 3.14159$$

$$= (144 - 100) \times 3.14159 = 44 \times 3.14159$$

$$= 138.22996 \text{ yards, nearly.}$$

(16) If the surface be cut by a plane passing through the axis of the cone, it may be *developed* so as to become a circular sector, whose radius = the slant height, and arc = the circumference of the base: whence, the convex surface of the cone = the area of this sector = the product of the circumference of the base and half its slant height.

THE PRACTICE OF SOLID MEASURE.

PAGE 209.

(1) The area of the base = $34 \times 34 = 1156$ square inches: whence, the volume of the prism = $1156 \times 149 = 172244$ solid inches = 99 solid feet, 1172 solid inches.

(2) The content of the cistern

$$= 4 \times 2\tfrac{1}{2} \times 3\tfrac{1}{4} = 4 \times \frac{5}{2} \times \frac{13}{4} = 32\tfrac{1}{2} \text{ cubic feet:}$$

whence, 1 : $32\frac{1}{2}$ :: 1000 oz. : 32500 oz., the weight required.

(3) Since the content = the length × the breadth × the depth, we have the depth always

$$= \frac{\text{the content}}{\text{the length} \times \text{the breadth}}:$$

and in this case, it $= \dfrac{294\frac{1}{4}}{9\frac{3}{4} \times 6} = 5\frac{7}{234}$ feet.

(4) Because the volume = the area of the base × the length, we have the length

$$= \frac{\text{the volume}}{\text{the area of the base}} = \frac{14.137155 \times 144}{18^2 \times 3.14159}$$

$$= \frac{14.137155 \times 4}{9 \times 3.14159} = \frac{56.54862}{28.27431} = 2 \text{ feet.}$$

(5) Here, the area of the base = 6 square feet: whence, the solid content of the pyramid = $\frac{1}{3}$ of the area of the base × the altitude = $\frac{1}{3}$ of $6 \times 6 = 12$ solid feet.

(6) The solid content of the sphere whose radius is 1 = 4.18879, nearly, and the solid content of its circumscribed cylinder = the area of a circle whose radius is 1, multiplied by the diameter = 3.14159×2: whence, the solid content of the sphere : the solid content of its circumscribed cylinder :: 4.18879 : 6.28318, nearly: and this approximate ratio is very nearly the same as 2 : 3,

and would have been actually so, had the constant multiplier used been absolutely correct: that is, the content of a sphere is *two-thirds* of that of its circumscribed cylinder.

(7) The volume of the cone $= \frac{1}{3} \times 3.14159$; the volume of the hemisphere $= \frac{2}{3} \times 3.14159$; the volume of the circumscribed cylinder $= 1 \times 3.14159$: and these are manifestly in the same proportion as the numbers 1, 2, 3.

(8) If the radius be 1, the volume of the sphere $= 4.18879$: also, the volume of the cone whose height is equal to the radius, and whose base is equal to *four* great circles of the sphere

$= \frac{1}{3}$ of $4 \times 1 \times 3.14159 = \frac{4}{3} \times 3.14159 = 4.18879$, nearly,

which establishes the truth of the Theorem.

See the remark made at the end of The Practice of Lineal Measure.

THE COMPUTATIONS OF ARTIFICERS.

PAGE 213.

(1)

	$14'.\ 6'$
	$12\ .\ 7$
	$174\ .\ 0$
	$8\ .\ 5\ .\ 6$
	$182'.\ 5'.\ 6''$

(2)

	$25'.\ 7'$
	$7\ .\ 10$
	$179\ .\ 1$
	$21\ .\ 3\ .\ 10$
	$200'.\ 4'.\ 10''$

(3)

	$16'.\ 5'$
	$12\ .\ 11$
	$197\ .\ 0$
	$15\ .\ 0\ .\ 7$
	$212'.\ 0'.\ 7''$

(4)

	$2'.\ 3'.\ 4''$
	$11\ .\ 11$
	$25\ .\ 0\ .\ 8$
	$2\ .\ 1\ .\ 0\ .\ 8$
	$27'.\ 1'.\ 8''.\ 8'''$

(5)

$$\begin{array}{r} 9'.\ 4'.\ 7'' \\ 5\ .\ 6\ .\ 4 \\ \hline 46\ .\ 10\ .\ 11 \\ 4\ .\ 8\ .\ 3\ .\ 6 \\ 3\ .\ 1\ .\ 6\ .\ 4 \\ \hline 51'.\ 10'.\ 4''.\ 0'''.\ 4'''' \end{array}$$

(6)

$$\begin{array}{r} 17'.\ 3'.\ 4'' \\ 19\ .\ 5\ .\ 11 \\ \hline 328\ .\ 3\ .\ 4 \\ 7\ .\ 2\ .\ 4\ .\ 8 \\ 1\ .\ 3\ .\ 10\ .\ 0\ .\ 8 \\ \hline 336'.\ 9'.\ 6''.\ 8'''.\ 8'''' \end{array}$$

(7)

$$\begin{array}{r} 0'.\ 10'.\ 3''.\ 4''' \\ 0\ .\ 5\ .\ 0\ .\ 6 \\ \hline 0\ .\ 0\ .\ 0\ .\ 0 \\ 4\ .\ 3\ .\ 4\ .\ 8 \\ 0\ .\ 0\ .\ 0\ .\ 0 \\ 5\ .\ 1\ .\ 8\ .\ 0 \\ \hline 0'.\ 4'.\ 3''.\ 9'''.\ 9^{iv}.\ 8^{v}.\ 0^{vi} \end{array}$$

(8)

$$\begin{array}{r} 13'.\ 2'.\ 6'' \\ 0\ .\ 1\ .\ 9\ .\ 10 \\ \hline 0\ .\ 0\ .\ 0 \\ 1\ .\ 1\ .\ 2\ .\ 6 \\ 9\ .\ 10\ .\ 10\ .\ 6 \\ 11\ .\ 0\ .\ 1\ .\ 0 \\ \hline 2'.\ 0'.\ 0''.\ 4'''.\ 7^{iv}.\ 0^{v} \end{array}$$

In these two solutions, the lines of ciphers are not absolutely necessary: they have been introduced to point out *distinctly* the local values of the terms in the lines

following, but may be altogether dispensed with, after a little practice.

(9) Here,

$$\begin{array}{r} 15^{f}.\ 5' \\ 9\ .\ 10 \\ \hline 138\ .\ 9 \\ 12\ .\ 10\ .\ 2 \\ \hline 151^{f}.\ 7'.\ 2'' \end{array}$$

and $151^{f}.7'.2'' = 151\,\text{ft.} + \frac{7}{12}\,\text{ft.} + \frac{2}{144}\,\text{ft.} = 151\,\text{ft.} + \frac{86}{144}\,\text{ft.}$

$= 151\,\text{ft.}\ 86\,\text{in.} = 16\,\text{yds.}\ 7\,\text{ft.}\ 86\,\text{in.}$

(10) Here, 19 yds. 3 in. = 57 ft. 3 in., and 9 yds. 1 ft. 6 in. = 28 ft. 6 in.: whence, we have

$$\begin{array}{r} 57^{f}.\ 3' \\ 28\ .\ 6 \\ \hline 1603\ .\ 0 \\ 28\ .\ 7\ .\ 6 \\ \hline 1631^{f}.\ 7'.\ 6'' \end{array}$$

which is $1631\,\text{ft.} + \frac{7}{12}\,\text{ft.} + \frac{6}{144}\,\text{ft.} = 1631\,\text{ft.} + 90\,\text{in.}$

$= 16\,\text{sq.}\ 31\,\text{ft.}\ 90\,\text{in.}$

(11) The area $= 5^{f}.\ 7' \times 3^{f}.\ 8' = 20^{f}.\ 5'.\ 8''$;

therefore, $1^{f} : 20^{f}.\ 5'.\ 8'' :: 3s. : x$,

or, $144'' : 2948'' :: 3s. : x$,

or, $12 : 737 :: 1s. : x$,

whence, $x = \frac{1}{12}$ of $737s. = £3.\ 1s.\ 5d.$

(12) The area $= 18^f \cdot 6' \times 14^f \cdot 3' = 263^f \cdot 7' \cdot 6''$:

therefore, $9^f : 263^f \cdot 7' \cdot 6'' :: 5s. : x$,

or, $1296'' : 37962'' :: 5s. : x$;

whence, $x = \frac{37962 \times 5}{1296} s. = £7.\ 6s.\ 5\frac{1}{2}d.$

(13) The area $= 34^f \cdot 9' \times 26^f \cdot 4' = 915^f \cdot 1'$:

whence, the value required is $915\frac{1}{12} s. = £45.\ 15s.\ 1d.$

(14) The circuit of the room = *twice* the sum of 20 ft. 10 in. and 16 ft. = *twice* 36 ft. 10 in. = 73 ft. 8 in.: whence, the surface of the walls will be

$73^f \cdot 8' \times 10^f \cdot 9' = 791^f \cdot 11' = 791$ sq. ft. 132 sq. in.

(15) The surface of the *walls* = *twice* 11 ft. 8 in. × the sum of 22 ft. 5 in. and 18 ft. 4 in.

$= 23^f \cdot 4' \times 40^f \cdot 9' = 950^f \cdot 10'$:

also, the surface of the *floor* and *ceiling* will be

$= 2 \times (22$ ft. 5 in. $\times 18$ ft. 4 in.$) = 44^f \cdot 10' \times 18^f \cdot 4' = 821^f \cdot 11' \cdot 4''$;

whence, the whole surface of the room is

$950^f \cdot 10' + 821^f \cdot 11' \cdot 4'' = 1772^f \cdot 9' \cdot 4''$

$= 1772$ sq. ft. 112 sq. in.

(16) The number required will manifestly be

$$15 \times 68\tfrac{9}{144} \div 272\tfrac{1}{4} = 15 \times 68\tfrac{1}{16} \div \frac{1089}{4} = 3\tfrac{3}{4}.$$

(17) The semi-sum of the sides $= \frac{1}{2}$ of $(2\frac{1}{4} + 3 + 3\frac{3}{4}) = \frac{9}{2}$, and the three remainders will therefore be $\frac{9}{4}$, $\frac{3}{2}$ and $\frac{3}{4}$: whence, the square of the area

$$= \frac{9}{2} \times \frac{9}{4} \times \frac{3}{2} \times \frac{3}{4} = \frac{9^2 \times 3^2}{2^2 \times 4^2}:$$

and the area itself will consequently be

$$= \frac{9 \times 3}{2 \times 4} = \frac{27}{8} \text{ sq. feet.} = 3 \text{ sq. ft. } 54 \text{ sq. in.}$$

(18) The volume $= 3^f.\ 10' \times 3^f.\ 10' \times 3^f.\ 10'$

$= 14^f.\ 8'.\ 4'' \times 3^f.\ 10' = 56^f.\ 3'.\ 11''.\ 4'''$

$= 56 + \frac{3}{12} + \frac{11}{144} + \frac{4}{1728} = 56\ \frac{568}{1728}$ solid ft.

$= 56$ solid ft. 568 solid in.

(19) The capacity $= 4^f.\ 6' \times 5^f.\ 7' \times 6^f.\ 8'$

$= 25^f.\ 1'.\ 6'' \times 6^f.\ 8' = 167^f.\ 6' = 167\frac{1}{2}$ cubic feet.

(20)

$$\begin{array}{r} 124^f.\ 2'\ .\ 4'' \\ 8\ .\ 4 \\ \hline 993\ .\ 6\ .\ 8 \\ 41\ .\ 4\ .\ 9\ .\ 4 \\ \hline 1034\ .\ 11\ .\ 5\ .\ 4 \end{array}$$

$$= 1034 + \frac{11}{12} + \frac{5}{144} + \frac{4}{1728}$$

$$= 1034 + \frac{1584 + 60 + 4}{1728}$$

$$= 1034 + \frac{1648}{1728} = 1034 \text{ ft. } 1648 \text{ in.}$$

(21) Here, $94\ \frac{235}{1728} \div 24\ \frac{5}{144} = 162667$

$\div 3461 = 47$ lineal inches $= 3$ ft. 11 in.

(22) Here, $1122\ \frac{36}{144} = 1122\frac{1}{4} = \frac{4489}{4}$

whose square root $= \frac{67}{2} = 33$ ft. 6 in.

(23) Here, 15 solid ft. 1080 solid in. $= 27000$ solid in., whose cube root $= 30$ in. $= 2$ ft. 6 in.

(24) The area of a *side* being $12^f.\ 3' = 12\frac{1}{4} = \frac{49}{4}$ square ft., the *edge* will be $\frac{7}{2}$ ft.: whence, the *capacity*, which is the cube of this $= \frac{343}{8}$ cubic ft. $= 42$ cubic ft. 1512 cubic in.

(25) The quotient $= \frac{1532^f.\ 9'.\ 9''}{81^f.\ 9'} = \frac{1532.8125}{81.75}$

$= 18.75$ ft. $= 18$ ft. 9 in.

(26) The length required $= \frac{1728}{14 \times 1\frac{1}{2}}$ in. $= \frac{1728}{21}$ in.

$= \frac{1728}{252}$ ft. $= \frac{432}{63}$ ft. $= \frac{48}{7}$ ft. $= 6$ ft. $10\frac{2}{7}$ in.

(27) Here, 73 yds. 1 ft. 8 in. $= 2648$ in., and 3 ft. 9 in. $= 45$ in.

then, $2648 \times 45 = 119160$ in.:

also, 94 ft. $\times$ 10 ft. $= 940$ ft. $= 135360$ in.,

therefore the difference of these $= 16200$ in. $= 112\frac{1}{2}$ ft.

(28) 2 ft. 6 in. $\times$ 9 in. $= 30$ in. $\times$ 9 in. $= 270$ in.,

therefore $270 \times 75 = 20250$ in. in 1 strip:

then $25312\frac{1}{2}$ in. $= 1\frac{1}{4}$ strip in one day:

therefore $25312\frac{1}{2} \times 8 = 202500$ in. in eight days $= 1406\frac{1}{4}$ ft.

(29) Here, 6 ft. 6 in. $\times$ 2 ft. 3 in. $= 78$ in. $\times$ 27 in. $= 2106$ in. in one revolution of roller:

then $2106 \times 12 = 25272$ in. in 12 revolutions or the length of the green, and since the roller passes 10 times, the whole area rolled $= 252720$ in. $= 195$ yards.

(30) Here, $24^f.\ 8' \times 12^f.\ 9' = 314\frac{1}{2}$ sq. ft., and $314\frac{1}{2}$ ft. $\times$ 1 ft. $= 314\frac{1}{2}$ cubic ft.

(31) Here, 14706 ft. 216 in. $= 14706\frac{1}{8} = \frac{117649}{8}$,

whose cube root $= \frac{49}{2}$ ft.: $\therefore$ the length of all the edges $= \frac{49}{2} \times 12 = 294$ ft.: and the area of all the faces $= \left(\frac{49}{2}\right)^2 \times 6 = 2401 \times \frac{3}{2} = 3601\frac{1}{2}$ ft.

THE COMPUTATIONS OF GAGERS.

PAGE 217.

(1) Here, the number of gallons is $1728 \div 277.274 = 6.232$, nearly.

(2) The volume of the cistern is $169 \times 125 \times 4 = 169 \times 500 = 84500$ cubic inches: whence, the content is $\frac{84500}{277.274} = 304.752$ gallons, nearly.

(3) The volume of the vessel $= 15 \times 15 \times 15 = 3375$ cubic inches, whence, the content

$= 3375 \div 277.274 = 12.172$ gallons, nearly.

(4) The volume of the vessel is $3.14159 \times 20^2 \times 54 = 67858.344$ cubic inches: whence, the content is

$67858.344 \div 277.274 = 244.733$ gallons, nearly.

(5) The number of bushels

$$= \frac{1 \times 27 \times 1728}{2218.192} = \frac{46656}{2218.192} = 21.033, \text{ nearly.}$$

(6) The number of bushels

$$= \frac{66 \times 48 \times 14}{2218.192} = \frac{44352}{2218.192} = 19.994 \text{ \&c.} = 20, \text{ nearly.}$$

(7) The volume $= 3$ ft. 4 in. $\times 2$ ft. 3 in. $\times 1$ ft. 2 in.

$= 40 \times 27 \times 14 = 15120$ cubic inches:

therefore the content $15120 \div 2218.192 = 6.816$ bushels, nearly.

(8) The height $= \frac{2218.192}{\frac{1}{4}(18.789)^2 \times 3.14159} = 8$ inches, nearly.

THE COMPUTATIONS OF LAND SURVEYORS.

PAGE 219.

(1) Here, $10\frac{1}{2}$ chains $= 10\frac{1}{2} \times 100$ links $= 1050$ links: whence, the area $= (1050)^2 = 1102500$ sq. links $= 11$ ac. 4 po.

(2) Here, 16 ch. 3 po. $= 16\frac{3}{4}$ ch. $= 16.75 \times 100 = 1675$ links: and 6 ch. 2 po. $= 6\frac{1}{2}$ ch. $= 6.5 \times 100 = 650$ links: whence, the area $= \frac{1}{2}$ of $1675 \times 650 = 544375$ square links $= 5$ ac. 1 ro. 31 po.

(3) The area $= \sqrt{782.5 \times 402.5 \times 362.5 \times 17.5}$

$= \sqrt{1998003710.9375}$

$= 44699.048$ square yards, nearly,

$= 9$ ac. 38 po., nearly.

(4) The diagonal $= 5.25$ ch. $= 525$ links: and the sum of the perpendiculars $= 5.5$ ch. $= 550$ links: whence, the area is $\frac{1}{2}$ of $525 \times 550 = 144375$ sq. links $= 1$ ac. 1 ro. 31 po.

(5) The area required $= \frac{1}{4}$ of $3.14159 \times \frac{700}{2} \times \frac{500}{2}$

$= .7853975 \times \frac{700}{2} \times \frac{500}{2}$

$= 7853.975 \times \frac{35}{4} = 1963.49375 \times 35$

$= 68772.28125$ square links

$=$ 2 ro. 30 po., nearly.

(6) The length of the field will manifestly be

$$\frac{100000}{250} = 400 \text{ links} = 4 \text{ chains.}$$

(7) Here, 2 ac. 4 po. $= 2\frac{1}{10}$ ac. $= 202500$ square links; therefore, the length of the side of the field will be

$$\sqrt{202500} = 450 \text{ links} = 4\frac{1}{2} \text{ chains.}$$

(8) Since, the areas of similar triangles are in the same proportion as the squares of their homologous sides, if x denote the length of the required line, we must have

the square of 11.313708 : the square of x :: 2 : 1;

whence, the square of $x = \frac{1}{2}$ of the square of 11.313708;

and therefore, $x = \frac{11.313708}{\sqrt{2}} = \frac{11.313708}{1.41421} = 8$ chains, nearly.

(9) Here, area of field = 4840 × 40 yds. = 193600 yards, and its side = $\sqrt{193600}$ = 440 yds. = 20 chains, so that its circuit = 20 × 4 = 80 chains.

Also, the half circuit or 40 chains = the length + the breadth = $\frac{10}{7}$ of the length; ∴ the length = $\frac{40 \times 7}{10} = 28$ ch., and the breadth = 12 ch.: ∴ the area = 336 ch. = 33 ac. 2 ro. 16 po.

(10) Here, area of whole − area of field = $\frac{9}{16}$ area of field, or area of whole = $\frac{25}{16}$ area of field; ∴ radius of field + breadth of path = $\frac{5}{4}$ of the radius of field: or, breadth of path = $\frac{1}{4}$ radius of field.

APPENDIX II.

MISCELLANEOUS QUESTIONS.

I.

(1)
$$\begin{array}{r} 39027 \\ 473 \\ \hline 117081 \\ 273189 \\ 156108 \\ \hline 18459771 \end{array}$$

$$\begin{array}{ccc} & 6 & \\ 5 & & 3 \\ & 6 & \end{array}$$

also,
$$\begin{array}{r|l} 625 & 7715625 \;(\; 12345 \\ & 625 \\ \hline & 1465 \\ & 1250 \\ \hline & 2156 \\ & 1875 \\ \hline & 2812 \\ & 2500 \\ \hline & 3125 \\ & 3125 \\ \hline \end{array}$$

(2) Here, G. C. M. = 2, and L. C. M. = 3780.

(3) Here,
9 ft. 2 in. = 110 in.: 1 mi. 440 yds. = 79200 in.:
$\therefore$ 79200 ÷ 110 = 720 revolutions.

(4) Here, $5s.\ 9\frac{3}{4}d. \times 1000 = £290.\ 12s.\ 6d.$

(5) Omitted.

(6) Here, 100 : 800 :: 96 : £768 stock: and he can buy £640 stock in the 4 per cents, and the interest will be £25. 12*s*.

(7) Here,

21*s*. + 20*s*. + 2*s*. 6*d*. + 1*s*. = 534*d*.: and £445 = 106800*d*.:

then, 106800 ÷ 534 = 200 = number of each.

(8) Here, £98. 15*s*. : £2370 :: 3 : sum required:

$$\text{or, sum required} = \frac{47400 \times 3}{1975} = £72.$$

(9) Here, £691. 15*s*. at 4 per cent for 1 year, gives £27. 13*s*. $4\frac{3}{4}d.\frac{1}{5}$: and in 15 years the interest will be £27. 13*s*. $4\frac{3}{4}d.\frac{1}{5} \times 15$ = £415. 1*s*., so that the amount is £1106. 16*s*.

(10) Here,

£1500
5
£75.00

and £1575 = amount in 1 year:

also,

£1575
5
£78.75
20
s.15.00

and £1653. 15*s*. = amount in 2 years:

also,

£1653.15*s*.
5
£82.68.15*s*.
20
s.13.75
12
d.9.00

and £1736. 8*s*. 9*d*. = amount in 3 years:

∴ interest required = £1736. 8*s*. 9*d*. − £1500 = £236. 8*s*. 9*d*.

(11) Omitted.

(12) Here, 3.375 tons = 7560 lbs.:

5.015625 cwts. = 561.75 lbs.:

3.1875 qrs. = 89.25 lbs.:

∴ the value = 7560 + 89.25 − 561.75 − 15.93359375 =7649.25−577.68359375=7071.56640625, and this divided by 25 gives 282.86265625, the decimal required.

II.

(1) Here,

$$\begin{array}{r|l} 1472 & 550974 \,(374 \\ & 4416 \\ \hline & 10937 \\ & 10304 \\ \hline & 6334 \\ & 5888 \\ \hline & 446 \end{array}$$

so that the quotient is 374, and the remainder is 446.

(2) Here, 40 lbs. troy = 230400 grs.: then, the weight of 1 sovereign $= \frac{230400}{1869} = 123.273$ grs. nearly:

and 1 oz. avoirdupois = $7000 \div 16 = 437\frac{1}{2}$ grs.:

∴ 123.273 : 437.5 :: 1 sov.: x,

or, $x = \frac{437.5}{123.273} = 3\frac{2707}{4931}$ sovereigns.

(3) Here, 2500 versts = $1666\frac{2}{3}$ miles:

∴ 10 mi. : $1666\frac{2}{3}$ mi. :: 1 hr. : time required:

or, time required = $1666\frac{2}{3} \div 10 = 166$ hrs. 40 min.

(4) Here, $4000 \times 5\frac{1}{4} = 3000 \times$ required months:

or, required time $= \frac{4000}{3000} \times \frac{21}{4} = \frac{4 \times 21}{3 \times 4} = 7$ months.

(5) Here, 3 : 141 :: 90 : sum required:

or, sum required $= \frac{141 \times 90}{3} = £4230.$

(6) Here, first cause $= 144 \times 3 \times 10$:

second cause $= x \times 15 \times 9$:

and first effect $= 120 \times \frac{3}{2} \times 4 = 720$:

second effect $= 180 \times 5 \times \frac{27}{12} = 2025$:

then, $144 \times 30 : 135 \times x :: 720 : 2025$:

or, $x = \frac{144 \times 30 \times 2025}{135 \times 720} = \frac{16 \times 30 \times 2025}{15 \times 720}$

$= \frac{16 \times 2 \times 2025}{720} = \frac{2 \times 2025}{45} = \frac{4050}{45} = 90$ men.

(7) Here, $1000 \times 18 =$ the required number $\times 20$:

or, required number $= \frac{18000}{20} = 900.$

(8) Here, amount of 100 = £100 + £2. 15*s.* = £102. 15*s.*:

then, £$102\frac{3}{4}$: £600 :: £$2\frac{3}{4}$: required discount:

or, required discount

$= \frac{600 \times 2\frac{3}{4}}{102\frac{3}{4}} = \frac{6600}{411} = \frac{2200}{137} = £16\frac{8}{137}.$

(9) Here, 2 ac. 3 ro. 5 po. $= 445 \times 30\frac{1}{4}$ yds.,

also, 151 yds. 9 in. $= 151\frac{1}{4}$ yds.:

$\therefore$ the breadth required

$= 445 \times 121 \div 605 = 445 \div 5 = 89$ yds.

(10) Here, 1 ton 1 cwt. 3 qrs. 14 lbs. = 2450 lbs.:
also, £61. 5*s*. + 50 per cent = £91. 17*s*. 6*d*.:
then, rate required $= \frac{22050}{2450} d. = 9d.$

(11) Here,
$$\begin{array}{ll} 200 \times 14 = 2800 & \\ 300 \times 19 = 5700 & \\ \hline 500 & 8500 \end{array}$$
and the equated time $= \frac{8500}{500} = 17$ months.

(12) Here, $16 \times 42 : x \times 7 :: 96 : 66$:
or, the number required
$$= \frac{16 \times 42 \times 66}{7 \times 96} = \frac{16 \times 6 \times 66}{96} = 66 \text{ days.}$$

III.

(1) Here, 753 bush. 3 pks. 1 gal. × 12 × 11 = 99511 bush.

(2) Here, $1\frac{1}{2}$ oz. = 24 dr.: 3 tons 2 cwt. 1 qr. 24 lbs. = 1790976 dr.:
then, 24 : 1790976 :: 30*f*. : sum required:
or, sum required $= \frac{1790976 \times 30}{24} f. = £2332.$

(3) Here, 10 × 2 : required time × 14 :: 10 : 70:
or, required time $= \frac{10 \times 2 \times 70}{14 \times 10} = 10$ days.

(4) Here, $7\frac{3}{4}$ of $\frac{24}{31}$ of $4\frac{3}{7} = \frac{31}{4}$ of $\frac{24}{31}$ of $\frac{31}{7}$
$$= \frac{6 \times 31}{7} = \frac{186}{7} = 26\tfrac{4}{7}:$$
and $2\frac{1}{2} - 3\frac{1}{3} + 4\frac{1}{5} = \frac{5}{2} - \frac{10}{3} + \frac{21}{5}$
$$= \frac{75 - 100 + 126}{30} = \frac{101}{30} = 3\frac{11}{30}.$$

(5) Here, $\frac{5}{6}=\frac{280}{336}$, $\frac{6}{7}=\frac{288}{336}$ and $\frac{7}{8}=\frac{294}{336}$:

$\therefore$ $\frac{7}{8}$ is the greatest and $\frac{5}{6}$ is the least.

(6) Here, $\frac{3}{4}\times\frac{6}{7}\times\frac{8}{9}\times\frac{10}{11}=\frac{40}{77}$,

also, $\frac{3}{4}\times\frac{10}{11}=\frac{30}{44}$ and $\frac{6}{7}\times\frac{8}{9}=\frac{48}{63}$:

and difference $=\frac{48}{63}-\frac{30}{44}=\frac{2112-1890}{2772}=\frac{222}{2772}$

$=\frac{111}{1386}=\frac{37}{462}$.

(7) Here, $2s.\ 9\frac{1}{2}d.=134f.$: $£1.\ 10s.\ 8\frac{1}{2}d.=1474f.$:

$\therefore$ the fraction required $=\frac{134}{1474}=\frac{67}{737}$:

also, $\frac{2}{3}$ of $2s.\ 6d.=20d.$, and $£2.\ 10s.=600d.$:

$\therefore$ the number of times $=\frac{600}{20}=30$.

(8) Here, $8\frac{5}{8}=8+\frac{5.000}{8}=8.625$:

and, $.109375=\frac{109375}{1000000}=\frac{21875}{200000}$

$=\frac{4375}{40000}=\frac{875}{8000}=\frac{175}{1600}=\frac{35}{320}=\frac{7}{64}$.

(9) Here, 4.7892) 7.83100000 (1.6351

47892

304180

287352

168280

143676

246040

239460

65800

47892

17908

(10) Here, £1. 12*s.* 4½*d.* = 1554*f.*: £7. 10*s.* = 7200*f.*:

$\therefore$ the decimal required $= \frac{1554}{7200} = .21583\dot{3}$.

(11) Here,

£712. 10*s.*	£17. 16. 3
2½	3½
1425. 0	53. 8. 9
356. 5	8. 18. 1½
17. 81. 5	£62. 6. 10½
20	
16. 25	
12	
3. 00	

(12) Here, $100 + 2 \times 4 =$ £108 = amount of £100 in 4 years: then £108 : £591. 13*s.* 4*d.* :: £8 : the discount:

or, discount $= \frac{\text{£591. 13}s.\ 4d. \times 8}{108} = \frac{\text{£591. 13}s.\ 4d. \times 2}{27}$

$= \frac{\text{£1183. 6}s.\ 8d.}{27} = \text{£43. 16}s.\ 6\tfrac{1}{2}d.\ \tfrac{2}{27}f.$

IV.

(1) Here,

£503. 4*s.* = 120768*d.*, and £10. 9*s.* 8*d.* = 2516*d.*:

$\therefore \frac{120768}{2516} = 48$ times, and 48 is an abstract number.

(2) Here, £401. 11*s.* 3*d.* ÷ 375 = £1. 1*s.* 5*d.*

(3) Here, 20×15 : sum required $\times 12$ :: 32 : 48:

and sum required $= \frac{20 \times 15 \times 48}{12 \times 32} = \frac{300}{8} = \text{£37. 10}s.$

(4) See Book.

Also, $\frac{2}{7}$ of $3\frac{1}{2}$ of $5\frac{1}{14} = \frac{2}{7}$ of $\frac{7}{2}$ of $\frac{71}{14} = \frac{71}{14} = 5\frac{1}{14}$.

(5) Here, the G. C. M. is found to be 495: and the terms being divided by 495, gives the fraction $\frac{98}{99}$:

and $1\frac{3}{5} = \frac{8}{5}$, $2\frac{4}{7} = \frac{18}{7}$ and $\frac{29}{8}$,

which are equivalent to $\frac{448}{280}$, $\frac{720}{280}$ and $\frac{1015}{280}$.

(6) Here, $37\frac{2}{11} + 24\frac{12}{13} = 62\frac{15}{143}$

and, $5\frac{11}{13} - 3\frac{1}{25} = \frac{76}{13} - \frac{76}{25}$

$= 76\left\{\frac{1}{13} - \frac{1}{25}\right\} = 76 \times \frac{12}{325} = \frac{912}{325} = 2\frac{262}{325}$.

(7) Here, the product $= \frac{1}{2} \times \frac{3}{4} \times \frac{5}{6} \times \frac{1}{3} \times \frac{4}{5} \times \frac{6}{7} = \frac{1}{14}$:

and the quotient $= 91\frac{1}{2} \div 15\frac{1}{4} = \frac{183}{2} \times \frac{4}{61} = 6$.

(8) Here, $£\frac{3}{5} = 12s.$: $\frac{5}{7}$ gui. $= 15s.$

$\frac{3}{8}s. = 4\frac{1}{2}d.$: and $1f. = \frac{1}{4}d.$:

$\therefore$ the sum $= £1.\ 7s.\ 4\frac{3}{4}d.$: the difference $= 3s.\ 4\frac{1}{2}d.$

(9) Here, $6\frac{1}{2}d. \frac{2}{3}f. = 80$, and $12d. = 144$:

$\therefore$ the fraction is $\frac{80}{144} = \frac{5}{9}$.

Also, $23\frac{1}{2}d. \times 276 = £31.\ 12s.\ 6d.$

(10) Here, $\frac{15}{64} = \frac{15.000}{8 \times 8} = \frac{1.875}{8} = .234375$.

(11) Here, $7.53 \times .0025 = .018825$.

(12) Here, $.27883100 \div .00001306 = 21350$.

V.

(1) Seven hundred and twenty eight millions, three hundred and eighty four thousand, five hundred and sixty nine: and 75000054.

(2) Here, $384129 \times 243 = 93343347$.

(3) Here, £1187. 10*s*. and £47. 10*s*. = int. for 1 yr.

	4		$3\frac{1}{2}$
47.50 .	0		142 . 10
	20		23 . 15
	10.00		166 . 5 = int. for $3\frac{1}{2}$ yrs.
			1187 . 10
			1353 . 15 = amt. in $3\frac{1}{2}$ yrs.

(4) Here, $£\frac{3328 \times 3\frac{3}{4}}{100} = £124.\ 16s.$

(5) Here, 1050 and 1050 . 0

	5		52 . 10
£52 .	50		1102 . 10 = amt. in 1 yr.
	20		
s.	10 . 00		

£1102. 10*s*. and 1102 . 10

	5		55 . 2 . 6
£55.12 .	10		1157 . 12 . 6 = amt. in 2 yrs.
	20		
s.	2.50		
	12		
d.	6.00		

£1157. 12*s*. 6*d*.

	5		£.	*s*.	*d*.
£57.88 .	2 . 6	and	1157 .	14 .	6
	20		57 .	17 .	$7\frac{1}{2}$
s.	17.62		1215 .	12 .	$1\frac{1}{2}$
	12		1050 .	0 .	0
d.	7.50		£165 .	12 .	$1\frac{1}{2}$
	4				
f.	2.00				

(6) Here, $90\frac{1}{5} : 135300 :: 100$: required sum:

or, sum required $= \frac{13530000}{90\frac{1}{5}} = \frac{13530000 \times 5}{451}$

$= £150000$, his capital:

also, the interest $\frac{150000 \times 3}{100} = £4500.$

(7) Here, amount of £100. in 11 mths at 4 per cent.

$= £103.\ 13s.\ 4d.$:

and $£103.\ 13s.\ 4d. : £596.\ 1s.\ 8d. :: £3.\ 13s.\ 4d.$:

or, $24880 : 143060 :: 880,$

or, $311 : 143060 :: 11,$

and discount $= \frac{143060 \times 11}{311} = 5060d.$

$= £21.\ 1s.\ 8d.$

(8) Here, $£600 + £800 + £1000 = £2400$:

then, $2400 : 600 :: 900$: first share,

or, first share $= \frac{600 \times 900}{2400} = £225$:

$2400 : 800 :: 900$: second share,

or, second share $= \frac{800 \times 900}{2400} = £300$:

$2400 : 1000 :: 900$: third share,

or, third share $= \frac{1000 \times 900}{2400} = £375.$

(9) Here, 135 yds. at $32s. = £216$:

and no. of dozens $= \frac{216}{2} = 108.$

(10) Here, 3 lbs. 8 oz. $= 56$ oz. : 1 ton $= 35840$ oz.:

$\therefore$ fraction required $= \frac{56}{35840} = \frac{1}{640} = .015625.$

(11) Here, fraction required $= \frac{46}{61} - \frac{3}{4} = \frac{1}{244}$.

(12) Here, fraction required $\div \frac{3}{5}$ of $\frac{6}{7} = \frac{4}{5}$ of $\frac{8}{7}$:

and fraction required $= \frac{4}{5}$ of $\frac{8}{7} \times \frac{3}{5}$ of $\frac{6}{7}$

$= \frac{576}{1225}$.

VI.

(1) The sum $= \frac{1}{5} + \frac{3}{8} + \frac{5}{14} + \frac{33}{35}$

$= \frac{23}{40} + \frac{25}{70} + \frac{66}{70} = \frac{23}{40} + \frac{91}{70} = \frac{23}{40} + \frac{13}{10}$

$= \frac{23}{40} + \frac{52}{40} = \frac{75}{40} = \frac{15}{8} = 1\frac{7}{8}$.

(2) Here, $\frac{3}{11}$ of $\frac{5}{18} = \frac{15}{198} = \frac{5}{66} = .07575$ &c.

$$\begin{array}{r} 12)\ 6.0 \\ \text{and}\quad 20)\ 7.500 \\ 15\left\{\begin{array}{r} 3)\ 9.375 \\ 5)\ 3.125 \\ .625 \end{array}\right. \end{array}$$

(3) Here,

1 oz. : 2 lbs. 5 oz. 13 dwts. 8 grs. :: £3. 17*s*. 10½*d*.

or, 480 : 14240 :: 3738,

or, 6 : 178 :: 3738,

or, 1 : 178 :: 623*f*.:

∴ required price $= 178 \times 623f.$

$= 110894f. =$ £115. 10*s*. 3½*d*.

(4) Here, £3. 17*s*. 8*d*. × 100 = £388. 6*s*. 8*d*.:

£3. 18*s*. 3*d*. × 50 = £195. 12*s*. 6*d*.:

then, 150 qrs. : 1 bush. :: £583. 19*s*. 2*d*.:

or, $\frac{£583.\ 19s.\ 2d.}{1200} = 9s.\ 8\frac{3}{4}d.\ \frac{1}{6}f.$

(5) Here, 7*s*. $0\frac{1}{2}d. = 338f.$:

then, $338 \times 505 = 170690f.$

= £177. 16*s*. $0\frac{1}{2}d.$, which differs from

£180. by £2. 3*s*. $11\frac{1}{2}d.$

(6) Here, 10 sq. ft. = 10 × 144 sq. in. = 1440 sq. in.:

then the length = $\frac{1440}{7\frac{1}{2}} = \frac{2880}{15} = 192$ in = 16 ft.

(7) Here, 5*s*. in the pound of $\frac{1}{2}$ his debt + 4*s*. in the pound on the other half = 9*s*. for £2.:

then, 9*s*. : £450 :: £2. : sum required,

or, sum required = £2000.

(8) Here, 100 : $107\frac{1}{2}$: 5*s*. 9*d*. : required price,

or, required price = $\frac{107\frac{1}{2} \times 5s.\ 9d.}{100} = 6s.\ 2\frac{7}{40}d.$

(9) Here, 88 : 22000 :: £2. 10*s*. : required sum,

or, required sum = $\frac{22000 \times £2.\ 10s.}{88} = £625.$

(10) Here, *A*, *B* and *C* have $\frac{1}{9}$, $\frac{2}{9}$ and $\frac{6}{9}$ respectively:

and 900 ÷ 9 = £100. for each part:

A has £100 : *B* has £200 : *C* has £600.

(11) Here, 27 × 5 × 10 : 16 × 9 × 12 :: 108 : number required:

∴ number required = $\frac{16 \times 9 \times 12 \times 108}{27 \times 5 \times 10} = 138\frac{6}{25}$ acres.

(12) Here, $13f.\ 7' \times 11f.\ 9' = 159f.\ 7'.\ 3''$

= 159 sq. ft. 87 sq. in.

VII.

(1) Here, 12cwt. 3qrs. : 2cwt. 3qrs. 14lbs. : £29. 15*s.* : sum required :

or, 1428lbs. : 322lbs. :: 7140*d.* : sum required :

or, sum required $= \frac{322 \times 7140}{1428} = 322 \times 5d.$

$= 1610d. = £6.\ 14s.\ 2d.$

(2) Here, £1. : £475. 10*s.* :: 10*s.* 6*d.* : sum required,

or, 20 : 9510 :: 126,

or, 1 : 951 :: 63 :

$\therefore$ sum required = £249. 12*s.* 9*d.*

(3) Here, $1878 \times 336 : 22536 \times 112 :: 702$: quantity required :

or, quantity required $= \frac{22536 \times 112 \times 702}{1878 \times 336} = 2808$ qrs.

(4) Here, $9\frac{7}{9} \div 3\frac{5}{7} = \frac{88}{9} \div \frac{26}{7}$

$= \frac{88 \times 7}{9 \times 26} = \frac{616}{234} = \frac{308}{117}.$

(5) Here, $3\frac{5}{8}$ of $\frac{7}{9}$ of $\frac{27}{301}$ of 49

$= \frac{29}{8}$ of $\frac{7}{9}$ of $\frac{27}{301}$ of $49 = \frac{4263}{344}.$

(6) Here, $\frac{2}{5}$ of 13*s.* 4*d.* $= \frac{£1.\ 6s.\ 8d.}{5} = 5s.\ 4d.$

(7) Here, $£\frac{5}{6} = 16s.\ 8d. : \frac{3}{8}s. = 4\frac{1}{2}d. : \frac{6}{12}d. = \frac{1}{2}d.$:

$\therefore$ the sum = 17*s.* 1*d.* :

and the answer $= \frac{17s.\ 1d.}{21s.} = \frac{205}{252} = .81349$ &c.

(8) Here, $27\frac{1}{4} \div \frac{54\frac{1}{2}}{93\frac{5}{11}} = \frac{27\frac{1}{4} \times 93\frac{5}{11}}{54\frac{1}{2}} = \frac{93\frac{5}{11}}{2} = 46\frac{8}{11}.$

(9) Here, the product = $.234 \times 4.32 = 1.01088$:

(10) See Book.

(11) Here,

cwt. 1.0225
4
qrs. 0.0900
28
lbs. 2.5200
16
oz. 8.3200

∴ value required = 1 cwt. 0 qrs. 2 lbs. 8.32 oz.

(12) Here, the square root = 1157625.

VIII.

(1) Here, premium on £5. 17*s*. 6*d*. at 10 per cent. = 11*s*. 9*d*.:

∴ the value of a share = £5. 17*s*. 6*d*. + 11*s*. 9*d*.
= £6. 9*s*. 3*d*.:

and the value of 1350 shares = £6. 9*s*. 3*d*. × 1350
= £8724. 7*s*. 6*d*.

(2) Here, £321. 10*s*. 6*d*. = 77166*d*.

and £12861 = 3086640*d*.:

$$\therefore \frac{3086640}{77166} = 40 \text{ times.}$$

(3) Here, £256. 12*s*. 6½*d*. = 246362*f*.:

and 3*s*. 6¾*d*. = 171*f*.:

and the quotient = 144 with a remainder = 122, which requires 49*f*. = 12¼*d*. to make up a complete quotient.

(4) Here, $\frac{5}{16} + 3\frac{17}{24} + \frac{5}{36} = \frac{599}{144}$:

then, the number to be added

$$= 5 - \frac{599}{144} = \frac{720 - 599}{144} = \frac{121}{144}.$$

(5) Here, .225 of £11. = 2·475£ = 594*d.*:

and .025 of £2. 6*s.* 8*d.* = .025 of 560*d.* = 14 .:

then the sum = 594*d.* + 14*d.* = 608*d.*:

also, decimal required = $\frac{608}{1200}$ = ·506.

(6) Here, £63. 5*s.* 7½*d.* = interest of £375. in the required time:

and interest of £375. in 1 year = £14. 1*s.* 3*d.*:

hence, 4½ yrs. is the time required, because £14. 1*s.* 3*d.* is contained 4½ times in £63. 5*s.* 7½*d.*

(7) Here, 1 ac. : 91 ac. 3 ro. 14 po. :: £1. 11*s.* 6*d.*,

or, 160 : 14694 :: 378,

or, 40 : 7347 :: 189:

and sum required = $\frac{7347 \times 189}{40}$ = 3471$\frac{23}{40}$*d.*

= £144. 12*s.* 10½*d.* $\frac{3}{10}$*f.*

(8) Here, £26. 17*s.* 10*d.* = interest in 1 year:

4

107 . 11 . 4 = interest in 4 years:

537 . 16 . 8 = principal:

£645 . 8 . 0 = amount.

(9) Here, £110. : £591. 12*s.* 4*d.* :: £100:

or, 11 : 591 . 12 . 4 :: 10:

10

11) 5916 . 3 . 4

£537 . 16*s.* 8*d.* = present worth:

∴ the discount = £591. 12*s.* 4*d.* − £537. 16*s.* 8*d.*

= £53. 15*s.* 8*d.*

(10) Here, the value of .04375£. = 10½*d.*:

and the value of .1015625 qrs. = 3 pks. 2 qts.

(11) Here, .25 of $\frac{12}{675}$ of .15 = $\frac{1}{1500}$.

(12) Here, the value of .3939, &c. = $\frac{39}{99} = \frac{13}{33}$;

also, the value of .1313, &c. of $\frac{13}{33} = \frac{169}{3267}$.

IX.

(1) Here, the price of stock + the commission
= £97. 10*s*. per cent.:
∴ the price of £1000. stock = £975.

(2) Here, £1000 × 5 + £1500 × 3 = 9500:
∴ 9500 : 4500 :: 1900 : *B*'s share,
or, *B*'s share = $\frac{4500 \times 1900}{9500}$ = £900.

(3) Here, $\frac{4}{5}$ of 1 ton = 1792 lbs, and $\frac{5}{8}$ of 1 lb. = 10 oz.
∴ the sum = 1792 lbs. 10 oz.

(4) Here, 60 × 20 : 30 × required weight :: £14½ : £5$\frac{7}{16}$:
or, required weight = $\frac{60 \times 20 \times 5\frac{7}{16}}{30 \times 14\frac{1}{2}}$ = 15 cwt.

(5) Here, the decimal = 45.625 ÷ 365 = .125:
and the vulgar fraction = $\frac{125}{1000} \times \frac{8}{11} = \frac{1}{11}$.

(6) Here, one chest costs 13706*f*:
and two chests cost 23004*f*:
∴ gain on transaction = £20. 16*s*. 4*d*. $\frac{1234}{3671}$*f*.

(7) Here, .65 of £4. 10*s*. = .65 of 1080*d*. = 702*d*.:
and .0125 of £5. 13*s*. 4*d*. = .0125 of 1360*d*. = 17*d*.:
then, the sum = 702*d*. + 17*d*. = 719*d*.:
and the decimal required = $\frac{719}{720}$ = .9986 &c.

(8) Here, the area $= \frac{3}{4}$ of $1760 \times 3 \times 53$

$= 440 \times 9 \times 53$:

then, $9f.$: $440 \times 9 \times 53f.$ :: $7\frac{1}{2}d.$: required cost,

or, required cost = £60. 14*s.* 7*d.*

(9) Here, the required fraction $\times \left(\frac{3}{8} + 1\frac{13}{24} + \frac{17}{36}\right) = 3$:

or, the required fraction $= 3 \div \frac{172}{72} = \frac{54}{43}$.

(10) Here, 94 : 100 :: $3\frac{1}{2}$: the required rate:

or, the required rate $= \frac{100 \times 3\frac{1}{2}}{94} = £3\frac{34}{47}$.

also, 94 : 1250 :: $3\frac{1}{2}$: the required income,

or, the income = $£46\frac{51}{94}$.

(11) Here, the amount of £100. in 9 mo. at 4 per cent. = £103:

then, 103 : 100 :: £715. 17*s.* : the present worth,

or, the present worth = £715. 17*s.* $\times \frac{100}{103}$ = £695:

also, $92\frac{2}{3}$: 695 :: £100 : the required stock:

or, the required stock = £750.

(12) Here, the length required $= 144 \div 7\frac{7}{5}$

$= \frac{1296}{70} = 18\frac{18}{35}$ inches.

X.

(1) Here, 96 mi. 1 mi. :: £2000000 : required rate:

or, required rate $= \frac{2000000}{8 \times 12} = \frac{250000}{12}$

= £20833. 6*s.* 8*d.*

(2) Here, $\frac{15}{16}-\frac{14}{15}+\frac{13}{14}-\frac{11}{12}=\frac{15}{16}+\frac{13}{14}-\frac{14}{15}-\frac{11}{12}$

$=\frac{210+208}{224}-\frac{168+165}{180}=\frac{418}{224}-\frac{333}{180}$

$=\frac{209}{112}-\frac{37}{20}=\frac{4180-4144}{2240}=\frac{9}{560}$.

and $\frac{8}{9}$ of a guinea $=\frac{168}{9}s.=\frac{56}{3}s.=18s.\ 8d.$:

$\frac{3}{4}$ of a half crown $=\frac{3}{4}$ of $30d.=1s.\ 10\frac{1}{2}d.$:

whence, the difference $=16s.\ 9\frac{1}{2}d.$

(3) See Book.

Here, the quotient $=\frac{17.084592}{\cdot 024}=711.858.$

and $7s.\ 10\frac{1}{2}d.=£.39375.$

(4) Here,

	2546
	$3\frac{1}{2}$
	7638
	1273
	89 . 11
	5
£	445 . 55 = interest in 5 years:
	20
s	11 . 00

∴ the interest required $=£445.\ 11s.$

(5) Here, the good debts $=£456.\ 18s.\ 10d.$:

also, $\frac{1}{5}$ of $£360.\ 7s.\ 10d.=£72.\ 1s.\ 6\frac{1}{5}d.$:

$\frac{1}{4}$ of $£120.\ 13s.\ 0d.=£30.\ 3s.\ 3d.$:

$\frac{9}{20}$ of £19. 18*s*. 0*d*. = £8. 19*s*. $1\frac{1}{2}d$. :

and the sum of these = $\frac{£568.\ 2s.\ 9d.}{3050}$ = 3*s*. $8\frac{1}{2}d$. $\frac{1256}{1525}f$.

(6) Here, the area of the floor = 28 × 19 = 532 ft. :

the width of the carpet = $\frac{3}{4}$ yd. = 27 in. :

∴ the length of the carpet = $\frac{532 \times 144}{27} = \frac{532 \times 16}{3}$ in. :

then, 36 : $\frac{532 \times 16}{3}$ :: 69*d*. : expense :

or, the expense = $\frac{532 \times 16 \times 69}{3 \times 36}$

$= \frac{532 \times 16 \times 23}{36} = \frac{133 \times 16 \times 23}{9} = \frac{48944}{9}$

$= 5438\frac{2}{9}d. = £22.\ 13s.\ 2\frac{2}{9}d.$

(7) Here, £2000 × 99 = the required stock × $90\frac{1}{8}$:

or, the required stock = $\frac{2000 \times 99}{90\frac{1}{8}} = \frac{16000 \times 99}{721}$:

and the income from it = $\frac{16000 \times 99}{721} \times \frac{3}{100}$

$= \frac{47520}{721} = £65\frac{455}{721}$:

∴ the difference of his income = £70 − $£65\frac{455}{721}$ = $£4\frac{345}{721}$.

(8) Here, *A*'s rate + *B*'s rate = 5 + $3\frac{1}{2}$ = $8\frac{1}{2}$ mi. :

then, $\frac{26}{8\frac{1}{2}} = \frac{52}{17} = 3\frac{1}{17}$ hrs.

(9) Here, 22 shares cost £132 : 78 shares £93. 12*s*. :

∴ the whole cost = £225. 12*s*. :

the sale price = (22 + 78) × 32*s*. = £160. 0*s*. :

and his loss = £225. 12*s*. − £160. = £65. 12*s*.

(10) Here, the decrease in the value of 1 oz.

$= £3.\ 17s.\ 10\frac{1}{2}d. - £3.\ 15s.\ 4\frac{1}{2}d. = 2s.\ 6d.$:

then, $£3.\ 17s.\ 10\frac{1}{2}d. : £1000 :: 2s.\ 6d.$: required sum:

$\therefore$ the required sum $= £\frac{120000}{3738} = £32\frac{84}{623}$.

(11) Here, $13 \times 15 \times 8 : 52 \times 12\frac{1}{2} \times 9 :: 7$: required sum:

or, the required sum $= \frac{52 \times 12\frac{1}{2} \times 9 \times 7}{13 \times 15 \times 8}$

$= £\frac{105}{4} = £26.\ 5s.$

(12) Here, the circuit of the gallery

$= 2 \times \{55\text{ft. }9\text{in.} + 10\text{ft. }2\text{in.}\} = 131\text{ft. }10\text{in.}$:

then, the area of the walls $= 131\text{ft. }10. \times 9\text{ft. }10\text{in.}$

$= 1296\text{ft.}\,.\,4'\,.\,4''$:

or, $1296'' : 186676'' ::$ 131 ft.: the required sum:

and the required sum $= \frac{186676 \times 131}{1296} f.$

$= £19.\ 13s.\ 3\frac{3}{4}d.\ \frac{79}{162} f.$

XI.

(1) Here, 1 qr. : 8 qrs. 2 bush. 3 pks. :: $31s.\ 4d. : x$,

or, 32 pks. : 267 pks. :: $376d. : x$:

that is, $x = \frac{267 \times 376}{32} = \frac{267 \times 47}{4} d.$

$= \frac{12549}{4} d. = £13.\ 1s.\ 5\frac{1}{4}d.$

(2) Here, $£\frac{7}{9} = \frac{140}{9} s.$, and $\frac{2}{5}$ gui. $= \frac{42}{5} s.$:

$\therefore$ the difference $= \frac{140}{9} - \frac{42}{5} = \frac{700-468}{45} = \frac{232}{45} = 5\frac{7}{15}s.$:

also, the fraction of 1 oz. $= \frac{232}{45 \times 5} = \frac{232}{225}$.

(3) Here, $5s. = 60d.$, and $13s.\ 4d. = 160d.$:

$\therefore$ the decimal $= \frac{60}{160} = \frac{3}{8} = .375$:

also, .07 of $50s. = 3.5s. = 3s.\ 6d.$

(4) Here, 12 : 8 :: 5 : interest of 100 in 8 months:

or, this interest $= \frac{40}{12} = \frac{10}{3} = £3.\ 6s.\ 8d.$:

or, $£103.\ 6s.\ 8d. : £245.\ 8s.\ 4d. :: 100 : x$:

or, $x = \frac{589 \times 100}{248} = £237.\ 10s.$

(5) Here, $(1) = 3.15 \times .0203 = .061915$:

$(2) = .00457 \times 32.56 = .1487992$:

$(3) = .013 \times .0016 = .0000208.$

(6) Here, $16f.\ 8' \times 12f.\ 4' = 205f.\ 6'.\ 8''$:

$\therefore$ length of carpet $= \frac{1}{3}\{205f.\ 6'.\ 8''\}$

$= 68f.\ 6'.\ 2\frac{2}{3}''.$

also, $3f. : 68f.\ 6'.\ 2\frac{2}{3}'' :: 81d. : x$;

or, $144 : 29600 :: 9d. : x$;

that is, $x = \frac{29600 \times 9}{144} d. = £7.\ 14s.\ 2d.$

(7) Here, $£2.\ 5s.\ 6d. \times 365 = £830.\ 7s.\ 6d.$:

or, his income $= £830.\ 7s.\ 6d. + £350 = £1180.\ 7s.\ 6d.$

(8) Here, $£\frac{2}{3} = 13s.\ 4d.$: $\frac{5}{6}$ of $2s.\ 6d. = 2s.\ 1d.$:

and $\frac{2}{9}$ of $1s. = 2\frac{2}{3}d.$:

or, the sum $= 15s.\ 7\frac{2}{3}d.$

Again, £.346 = 6.92*s.*, and .295 gui. = 6.125*s.*:
or the former is the greater.

(9) Here, 1 ton 7 cwt. = 3024 lbs.;

$\therefore$ number of parcels $= \frac{3024}{18} = 168.$

(10) Here, 45 ac. : 8 ac. 2 ro. :: £50. 12*s.* 6*d.* : x,

or, $x = \frac{34 \times 12150}{180} d. = £9.\ 11s.\ 3d.$

(11) Here, $8 \times 14 : 10 \times x ::$ 112 ac. : 200 ac.:

or, $x = \frac{8 \times 14 \times 2000}{10 \times 112} = 200$ men.

(12) Here, required fraction

$$= \frac{24 \text{ d. } 2 \text{ hrs. } 8 \text{ min.}}{30 \text{ d.}} = \frac{289}{360}.$$

XII.

(1) See Book.

(2) Here, *B* counts 780 in 6 seconds: *A* in 2 seconds having to begin again, counts $100 \times 4 = 400$:

C in 3 seconds having to begin again, counts $160 \times 3 = 480$:

$\therefore$ the number by all $= 400 + 480 + 780 = 1660$.

(3) Here, 20 guineas = 840 sixpences:

also, 1 half-crown + 1*s.* + 6*d.* = 48*d.* = 8 sixpences,

and the number of each $= 840 \div 8 = 105$.

Also, 105 half-crowns = £13. 2*s.* 6*d.*: 105*s.* = £5. 5*s.*

and 105 sixpences = £2. 12*s.* 6*d.*

(4) Here,

1 mi. 3 fur. 5 po. : 51 mi. 4 fur. :: 4 cwt. 3 qr. 24 lbs. 4 oz. : x:

or, $x = \frac{16480 \times 89000}{445} = 3296000$ oz.

= 91 tons 19 cwt. 1 qr. 4 lbs.

(5) Here, the clear value of the first legacy
$= £4000 - £40 = £3960$:

or, $\left(1 - \frac{1}{10}\right)$ of second legacy $= £3960$:

$\therefore$ second legacy $= £3960 \times \frac{10}{9} = £4400$.

(6) See Book.

Also, $\frac{2}{3}$ of $\frac{4}{5}$ of $\frac{7}{9}$: $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{9}{11}$ :: £4312 : x,

or, $x = \frac{135 \times 135}{4}$ £. $= £4556.\ 5s.$

(7) Here, 3qrs. 15lbs. 3oz. $3\frac{1}{8}$dr. $= 25395\frac{1}{8}$drs.:
and 1 cwt. $= 28672$ drs.:

$\therefore$ required fraction $= \frac{25395\frac{1}{8}}{28672} = \frac{126976}{143360} = \frac{31}{35}$:

also, $\frac{34}{35}$ of a guinea $= \frac{34}{35} \times 21s. = \frac{102}{5}s.$
$= 20\frac{2}{5}s. = £1.\ 10s.\ 4\frac{3}{4}d.\ \frac{1}{5}f.$

(8) Here, $\frac{5}{18} + \frac{7}{27} + \frac{11}{54} = \frac{15+14+11}{54} = \frac{40}{54} = \frac{20}{27}$:

and $\therefore$ the remainder $= 1 - \frac{20}{27} = \frac{7}{27}$.

Again, A receives $\frac{3}{14}$ of $\frac{7}{27} = \frac{1}{18}$, B receives $\frac{2}{7}$ of $\frac{7}{27} = \frac{2}{27}$, C receives $\frac{1}{2}$ of $\frac{7}{27} = \frac{7}{54}$:

$\therefore$ the entire receipt of $A = \frac{5}{18} + \frac{1}{18} = \frac{6}{18} = \frac{1}{3}$:

..... of $B = \frac{7}{27} + \frac{2}{27} = \frac{9}{27} = \frac{1}{3}$:

..... of $C = \frac{11}{54} + \frac{7}{54} = \frac{18}{54} = \frac{1}{3}$.

(9) Here, the quotient

$$= \frac{521.125}{1.25} = \frac{521125}{1250} = \frac{4169}{10} = 416.9.$$

(10) Here,

£273. 15*s.*
4½
1095 . 0
136 . 17 . 6
£12.31 . 17 . 6
20
s. 6 . 37
12
d. 4 . 50
4
f. 2 . 00

then, interest in 3 yrs. = £36. 19*s.* 1½*d.*:
interest in 4 mths. = £4. 2*s.* 1⅔*d.*
interest in 85 days = £2. 17*s.* 4½*d.*:
∴ entire interest = £43. 18*s.* 7½*d.*

(11) Here, 20lbs. at 5½*d.* = 440*f.*:
18 lbs. at 5*d.* = 360*f.*:
16 lbs. at 4½*d.* = 288*f.*:
31 lbs. at 4¼*d.* = 527*f.*:
∴ the cost of 85 lbs. = 1615*f.*:
or, the cost of 1 lb. $= \frac{1615}{85}f. = 19f. = 4\frac{3}{4}d.$

(12) Here, $84^2 = 7056$, $105^2 = 11025$, $112^2 = 12544$: and the sum of these = 30625, whose square root is 175.

Also, $.9^3 = .729$, $(1.2)^3 = 1.728$ and $(1.5)^3 = 3.375$, and the sum of these = 5.832, whose cube root = 1.8.

XIII.

(1) Here, the G.C.M. is 346.

(2) Here, 18 ft. 4 in. = 220 in.: 5 miles = 26400 in.:
and the number of revolutions = 26400 ÷ 220 = 120.

(3) Here, 25 cwt. 3 qrs. 21 lbs. 13 oz. × 29
= 752 cwt. 1 qr. 16 lbs. 9 oz.

(4) Here, £1 : £4050 :: 7*s.* 6*d.* : *x*,
or, required sum = 4050 × 90*d.* = 364500*d.* = £1518.

(5) Here,

$$1\tfrac{7}{8} \text{ of } 1\tfrac{3}{5} \text{ of } 13\tfrac{1}{15} = \frac{15}{8} \text{ of } \frac{8}{5} \text{ of } \frac{196}{15} = \frac{196}{5} = 39\tfrac{1}{5}:$$

$$\text{and, } \frac{6\frac{4}{9}}{13\frac{1}{14}} \text{ of } \frac{8\frac{5}{7}}{23\frac{1}{5}} = \frac{\frac{58}{9}}{\frac{183}{14}} \text{ of } \frac{\frac{61}{7}}{\frac{116}{5}}$$

$$= \left(\frac{58}{9} \times \frac{61}{7}\right) \div \left(\frac{183}{14} \times \frac{116}{5}\right) = \frac{58}{9} \times \frac{61}{7} \times \frac{14}{183} \times \frac{5}{116}$$

$$= \frac{58 \times 61 \times 14 \times 5}{9 \times 7 \times 183 \times 116} = \frac{1 \times 1 \times 2 \times 5}{9 \times 1 \times 3 \times 2} = \frac{5}{27}.$$

(6) Here, the sum $= \frac{3}{4} + 1\frac{1}{2} + 2\frac{5}{8} = 4\frac{5}{8}$:

also, 17*s.* $6\frac{3}{4}$*d.* = 843*f.* : £20 = 19200*f.*:

$\therefore$ required fraction $= \frac{843}{19200} = \frac{281}{6400}$.

(7) See Book.

(8) Here, 123.432 × 21.34 = 2634·03888.

(9) Here, 800 × 96 = required stock × 120:

or, required stock $= \frac{800 \times 96}{120} =$ £640,

the interest of which at 4 per cent. = £25. 12*s.*

(10) Here, amount of £100. in 7 months = £$102\frac{11}{12}$:

then, $102\frac{11}{12}$: $849\frac{1}{16}$ :: $2\frac{11}{12}$: the discount:

or, the discount = $(849\frac{1}{16} \times 2\frac{11}{12}) \div 102\frac{11}{12}$

$= \frac{13585 \times 7}{247 \times 16} = £\frac{385}{16} = £24.\ 1s.\ 3d.$

(11) Here, the square root = 5.37:

also, $3^3 + 4^3 + 5^3 = 27 + 64 + 125 = 216 = 6^3$;

or, the cube root = 6.

(12) Here, the solid feet = 30 ft. 7 in. × 13 ft. 8 in. × 1 ft. 2 in. = $487f.\ 7'.\ 7'' 4''' = 487\frac{137}{216}s.$ ft.

= 487 solid feet, 1096 solid in.

XIV.

(1) Here, the product = 123246469 × 7 × 7

= 862725283 × 7 = 6039076981:

Also, $8)\ 6039076981$

$9)\ 754884622\ .\ 5$

$83876069\ .\ 1$ } 13 remainder.

(2) Here, $13338)\ 15903\ (1$

13338

$2565)\ 13338\ (5$

12825

$513)\ 2565\ (5$

2565

or, the G. C. M. is 513.

Also, $2)\ 1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ 8,\ 9$

$2)\ 1,\ 1,\ 3,\ 2,\ 5,\ 3,\ 7,\ 4,\ 9$

$3)\ 1,\ 1,\ 3,\ 1,\ 5,\ 3,\ 7,\ 2,\ 9$

$1,\ 1,\ 1,\ 1,\ 5,\ 1,\ 7,\ 2,\ 3$:

or, the L. C. M. = $12 \times 5 \times 7 \times 2 \times 3 = 2520$.

(3) Here, 18 lbs. 10 oz. 15 dwts. = 108840 grs.:

Also,
$$24\begin{cases}4)\ 108840\\ 6)\ 27210\end{cases}$$
$$20)\ 4535$$
$$12)\ 226 \text{ oz. } 15 \text{ dwts.}$$
$$\text{lbs. } 18 \text{ . } 10 \text{ oz. } 15 \text{ dwts.}$$

(4) Here, 6*s.* 8*d.* = 80*d.*: £1815. 6*s.* 8*d.* = 435680*f.*:
∴ the number of pieces = 435680 ÷ 80 = 5446:
and 5446 × 80 = 435680*d.* = £1815. 6*s.* 8d.

(5) Here, 12 oz. 13 drs. = 205 drs.:
and 12 cwt. 3 qrs. 7 lbs. = 1435 × 16 × 16 drs.:
$$\therefore \text{ the number of weights} = \frac{1435 \times 16 \times 16}{205} = 1792.$$

(6) Here, 162 qrs. 1 bush. 1 pk. 0 gal.

127	.	4	. 3	. 1
34	.	4	. 1	. 1

(7) Here, £1. 18*s.* 6½*d.*
$12 \times 9 + 6 = 114$

23	.	2	. 6
			9
208	.	2	. 6
11	.	11	. 3
£219	.	13	. 9

Also, £219. 13*s.* 9*d.* ÷ 114 = £1. 18*s.* 6½*d.*

(8) Here, 37)211 mi. 1 fur. 39 po. (51 mi. 5 fur. 27 po.

185

26

8

209

185

24

40

999

74

259

259

(9) Here, £18. 16*s*. $4\frac{1}{4}d.$ = 18065*f*. £263. 8*s*. $11\frac{1}{2}d.$ = 252910*f*.:

$$\therefore \text{ the number} = \frac{252910}{18065} = 14.$$

(10) Here, 1 wk. : 52 wks. :: £5. 6*s*. $4\frac{3}{4}d.$

$8 \times 6 + 4 = 52$

42 . 11 . 2

6

255 . 7 . 0

21 . 5 . 7

£276 . 12 . 7 = expenses:

and his saving = £343. 15*s*. − £276. 12*s*. 7*d*. = £67. 2*s*. 5*d*.

(11) Here, £1. : £3000. 10*s*. :: 1*s*. 2*d*. : *x*,

or, *x* = £175. 0*s*. 7*d*., and what he has left

= £3000. 10*s*. − £175. 0*s*. 7*d*. = £2825. 9*s*. 5*d*.

(12) Here, £7680. : 1 :: £1656 : *x*,

or, $x = \frac{1656}{7680}$ £. = 4*s*. $3\frac{3}{4}d.$

XV.

(1) Here, $40000 - 7857 = 32143$:

$\therefore\ 32143 \times 7857 = 252547551$ = the product.

(2) Here, 3 bush. 3 pks. 1 gal. 3 qts.

$2 \times 9 + 1 = 19$

7	.	3	.	1	. 2
					9
71	.	1	.	1	. 2
3	.	3	.	1	. 3
bush. 75	.	1	.	1	. 1

(3) Here, $48 \times 42 = 2016$ gallons:

$\therefore\ \dfrac{2016}{32} = 63$, the required number.

(4) Here, carriage of 2 cwt. 3 qrs. for 192 mi. = 12*s.*:

$\therefore$ carriage of 2 cwt. 3 qrs. for 128 mi. = 8*s.*:

then, 2 cwt. 3 qrs. : 1 cwt. 1 qr. :: 8*s.* : x,

or, $x = 3s.\ 9\frac{1}{2}d.$

(5) Here, £2. 13*s.* $4\frac{1}{2}d.$ = 2562*f.*:

£3. 14*s.* $5\frac{3}{4}d$ = 3575*f.*:

then, the required fraction = $\dfrac{2562}{3575}$:

also, $2\frac{1}{7}$ gui. = $\dfrac{18}{7} \times 21s. = 54s.$:

and the fraction required = $\dfrac{54}{180} = \dfrac{3}{10}$.

(6) Here, $\dfrac{2}{3}$ of the remainder = $\dfrac{2}{3}$ of $\dfrac{1}{5} = \dfrac{2}{15}$:

then, $\dfrac{4}{5} : \dfrac{2}{15}$ :: £675. 15*s.* : sum required :

or, sum required $= \frac{2}{15} \times$ £675. 15*s*. $\times \frac{5}{4}$

$= \frac{1}{6}$ of £675. 15*s*. = £112. 12*s*. 6*d*.

(7) Here, £2.0375 × 20 × 12 = 489*d*. :

and lbs. 625 ÷ 28 = ·02225 qrs. = ·0055625 cwts.

(8) Here, 100×10 : required sum × 15 :: £3. 10*s*. : £21 :

or, required sum $= \frac{100 \times 10 \times 420}{15 \times 70}$ = £400.

(9) Here, the interest required

= £237. 5*s*. 6*d*. $\times \frac{5}{100} \times 4$ = £47. 9*s*. $1\frac{5}{7}$*d*.

(10) Here, the annual income $= \frac{3}{100} \times$ £450 = £135.

also, £100 : £4500 :: £96$\frac{4}{5}$: sum required :

or, sum required $= \frac{4500 \times$ £96. 12*s*. 6*d*.$}{100}$

= £96. 12*s*. 6*d*. × 5 × 9 = £4348. 12*s*. 6*d*.

(11) Here, £5000 − £500 = £4500 stock :

then, 100 : 4500 :: £94. 7*s*. 6*d*. : required sum :

or, the required sum = £94. 7*s*. 6*d*. × 5 × 9

= £4246. 17*s*. 6*d*.

(12) Here, the amount of £100 = £120 :

then, £120 : £1242 :: £100 : present worth :

or, present worth $= \frac{12420}{12}$ = £1035 :

and the discount = £1242 − £1035 = £207.

XVI.

(1) Here, the product $= 392163 \times 578 = 1991403714$:

and the quotient $= \frac{392163 \times 578}{289} = 392163 \times 2 = 784326.$

(2) Here, $54 = \begin{cases} 6) & 425 \text{ tons. } 15 \text{ cwt. } 2 \text{ qrs. } 12 \text{ lbs.} \\ 9) & 70 \ . \ 19 \ . \ 1 \ . \ 2 \end{cases}$

tons $7 \ . \ 17 \ . \ 2 \ . \ 22$

(3) Here, 37) 422 mi. 3 fur. 38 po. (11 mi. 3 fur. 14 po.

37

52
37

15
8

123
111

12
40

518
37

148
148

then, the distance required = 11 mi. 3 fur. 14 po. × 3
= 34 mi. 2 fur. 2 po.

(4) Here, £1000 − £434. 5*s.* = £565. 15*s.*:

then, 365 : 1 :: £565. 15*s.* : x:

or, his daily expenditure $= \frac{£565.\ 15s.}{365}$

$= \frac{£113.\ 3s.}{73} = £1.\ 11s.$

(5) Here, 8×7 : required number $\times 3\frac{1}{2} :: 28 ; 42$;

or, the number required $= \dfrac{8 \times 7 \times 42}{28 \times 3\frac{1}{2}} = 24.$

(6) Here, £2. 1*s*. $0\frac{3}{4}d. = 1971f.$:

£5. 8*s*. 9*d*. $= 5220f.$:

or, the required fraction $= \dfrac{1971}{5220} = \dfrac{219}{580}.$

Also, $\dfrac{5}{6}$ of £2 $= £\dfrac{10}{6} = £\dfrac{5}{3} =$ £1. 13*s*. 4*d*.

$\dfrac{9}{14}$ of 2gui. $= \dfrac{9}{7}$gui. = £1. 7*s*. 0*d*.

(7) Here, the required worth $= \dfrac{2}{7} \times \dfrac{14}{21} \times \dfrac{23}{25} \times$ £10000

$= \dfrac{2}{7} \times \dfrac{2}{3} \times \dfrac{23}{25} \times$ £10000 $= \dfrac{920000}{525}$

$= \dfrac{184000}{105} = \dfrac{36800}{21} =$ £1752$\frac{8}{21}$.

(8) Here, $\dfrac{3}{8}$ of $\dfrac{9}{24}$ of £24 $= £\dfrac{27}{8} =$ £3. 7*s*. 6*d*.:

and $\dfrac{3}{7}$ of $\dfrac{5}{6}$ of 30gui. $= \dfrac{15 \times 30}{42}$gui. = £11. 5*s*. 0*d*.:

$\therefore$ the difference = £7. 17*s*. 6*d*. = 1890*d*.

(9) Here, the interest = £234. 0*s*. $10\frac{3}{4}d. \frac{1}{5}f.$:

and the amount = £1696. 16*s*. $6\frac{3}{4}d. \frac{1}{5}f.$

(10) Here, the amount of £100 in 3 years at 4 per cent. = £112:

then, £112 : £3875. 4*s*. :: 100 : x,

or, $x = \dfrac{100}{112} \times$ £3875. 4*s*. $= \dfrac{25}{28} \times$ £3875. 4*s*. = £3460:

and the discount = £3875. 4*s*. − £3460 = £415. 4*s*.

(11) Here, $\frac{17}{1500} = .001133$ &c.:

also, the required value = .001133 &c. of £1000 = £1.133 &c. = £1. 2*s*. 8*d*.

(12) Here, the value required is £263. 3*s*. $0\frac{1}{4}d$.

XVII.

(1) Here, the product is 66232803.

(2) Here, number required $= \frac{£253.\ 12s.\ 6d.}{2s.\ 6d.}$

$$= \frac{60870}{30} = 2029.$$

(3) Here, the number = £892. 10*s*. ÷ £2. 12*s*. 6*d*.

$$= \frac{214200}{630} = 340.$$

(4) Here, £52. 10*s*. $7\frac{1}{2}d$. ÷ 41 = £1. 5*s*. $7\frac{1}{2}d$.

(5) Here, 377 : 20 :: £1589. 5*s*. $9\frac{3}{4}d$. : x,

or, x = £84. 6*s*. 3*d*.

(6) Here,

7 oz. 5 dwts. 20 grs. : 352 lbs. 3 oz. 6 dwts. 21 grs. :: 12 : x,

or, $x = \frac{24349500}{3500} = 6957d.$ = £28. 19*s*. 9*d*.

(7) Here, 20 × 6 : number of days × 15 :: 300 : 600:

or, $x = \frac{20 \times 6 \times 600}{15 \times 300} = \frac{72000}{4500} = 16.$

(8) Here,

2000 × 7 : required time × 770 :: £200 : £121 :

or, $x = \frac{2000 \times 7 \times 121}{770 \times 200} = 11$ months.

(9) Here, $\frac{1}{3}$ of $\frac{4}{17}$ of $6\frac{3}{8} = \frac{1 \times 4 \times 51}{3 \times 17 \times 8} = \frac{1}{2}$,

also, G.C.M. = 303, and fraction required = $\frac{67}{111}$

(10) Here, £80 = 19200*d.*, and £3. 6*s.* 9*d.* = 800*d.*:

$\therefore$ fraction required = $\frac{800}{19200} = \frac{1}{24}$.

(11) Here, the interest = £1071.

(12) Here, $100 \times 12 : 2000 \times 18 :: £12.\ 10s. : x$;

or, $x = \frac{2000 \times 18 \times 12\frac{1}{2}}{100 \times 12} = £375.$

XVIII.

(1) Here, the product = 33512972.

(2) Here, the quotient is 781682968 with a remainder 33.

(3) Here, £375. 13*s.* $4\frac{3}{4}$*d.* = 360643*f.*

(4) Here, 10000000*f.* = £10416. 13*s.* 4*d.*

(5) Here, $13\frac{1}{2}d. \times 365 = £20.\ 10s.\ 7\frac{1}{2}d.$:
his income = £25. 10*s.* $7\frac{1}{2}$*d.*

(6) Here, the cost = £1000. 10*s.* 10*d.* $\times \frac{12}{84}$

= £142. 18*s.* $8\frac{4}{7}$*d.*

(7) Here, £100 : £150 :: 69*d.* : *x*;

or, *x* = 8*s.* $7\frac{1}{2}$*d.*

(8) Here, $\frac{3}{7} + \frac{5}{14} + \frac{11}{21} + \frac{27}{28} = 2\frac{23}{84}$.

(9) Here, $\frac{3}{13} = .\dot{2}30769\dot{}$.

(10) Here, the fraction $= \frac{£2.\ 3s.\ 4\frac{1}{2}d.}{£3} = \frac{347}{480}$.

(11) Here,

4) 3.00

12) 6.75

20) 10.5625

50) 5.528125

.1105625 = decimal required.

(12) Here, $\frac{£20.\ 3s.\ 8\frac{1}{4}d.}{£60.\ 11s.\ 0\frac{3}{4}d.} = \frac{1}{3} = .\dot{3}$:

and $\frac{1}{10}$ of $\frac{£3.\ 13s.\ 4d.}{£44} = \frac{1}{120} = .00\dot{8}3\dot{}$.

XIX.

(1) Here, the quotient is 120190, with a remainder 29.

(2) Here, 196311 dr. = 6 cwt. 3 qrs. 10 lbs. 13 oz. 7 dr.

(3) Here, 1 sov. = 20*s.*: 2 gui. = 42*s.*:

then, $\frac{310 \times 20}{20 + 42} = 100$:

∴ the value of the sovereigns = £100:

and the value of the guineas = £210.

(4) Here, gain on $8\frac{1}{2}d. = 1s.\ 0\frac{3}{4}d. - 8\frac{1}{2}d. = 4\frac{1}{4}d.$:

then, $8\frac{1}{2}d.$: £100 :: $4\frac{1}{4}d.$: x;

or, $x = \frac{100 \times 4\frac{1}{4}}{8\frac{1}{2}} = 50$ per cent.

(5) Here, the income required = £480. 0*s.* $3\frac{3}{4}d.$

(6) Here,

	£.	s.	d.
35 { 5)	758	14	11
7)	151	14	$11\frac{1}{5}$
	£21	13	$6\frac{24}{35}$

(7) Here, £9. 10*s*. 6*d*. : £47. 12*s*. 6*d*. :: 10 days : x;

or, 1 : 5 :: 10 : x:

that is, $x = 50$ days.

(8) Here, 7 days : 273 days :: 13*s*. 6*d*. : x;

or, $x = \frac{273}{7} \times 13s.\ 6d. = £26.\ 6s.\ 6d.$

(9) Here, £1. 2*s*. : £44. :: 5*s*. 6*d*. : x;

or, $x = £11$.

(10) Here, $121\frac{5}{11} = \frac{1331+5}{11} = \frac{1336}{11}$:

and $344\frac{24}{29} = \frac{9976+24}{29} = \frac{10000}{29}$.

(11) Here, $3\frac{13}{21} = \frac{76}{21}$ and $5\frac{15}{76} = \frac{395}{76}$,

and the product $= \frac{76}{21} \times \frac{395}{76} = \frac{395}{21} = 18\frac{17}{21}$.

(12) Here, the product

$= 287.35 \times 537.82 = 154542.577$.

XX.

(1) Here, £32. 17*s*. $6\frac{1}{2}d$. $\times$ 30 = £986. 6*s*. 3*d*.:
and £1000 − £986. 6*s*. 3*d*. = £13. 13*s*. 9*d*.

(2) Here, £1 : £1367. 10*s*. :: 6*s*. $2\frac{1}{2}d$. : x;
or, $x =$ £424. 9*s*. $10\frac{1}{4}d$.

(3) Here,

1000 × 7 : sum required × $5\frac{1}{2}$ :: £50 : £60. 10*s*. :

$\therefore$ sum required $= \frac{1000 \times 7 \times 60\frac{1}{2}}{50 \times 5\frac{1}{2}} = \frac{1000 \times 7 \times 121}{50 \times 11}$

$= 20 \times 7 \times 11 =$ £1540.

(4) Here, the fraction $= \frac{7}{8}$ of $(2\frac{1}{4} + 3\frac{2}{5})$

$= \frac{7}{8}$ of $\left(\frac{9}{4} + \frac{17}{5}\right) = \frac{7}{8}$ of $\frac{113}{20} = \frac{791}{160}$.

(5) Here, $\frac{1}{4}$ of $\frac{6}{7}$ of 1 qr. $= \frac{3}{14}$ qrs. $= 6$ lbs. :

also, 1 ton $= 20 \times 4 \times 28$ lbs. $= 2240$ lbs. :

and the required fraction $= \frac{6}{2240} = \frac{3}{1120}$:

and $\frac{3}{1120} = \frac{3}{1120}$ of $2240 = 6$ lbs.

(6) Here, $\frac{1}{5}$ of a mile $= \frac{1}{5}$ of 5280 f. $= 1056$ ft. :

and $\frac{5}{8}$ lea. $= \frac{5}{8}$ of 5280 yds. $= 3300$ yds.

(7) Here, the quotient $= 2250000$.

(8) Here, $x = £26953125$.

(9) Here, interest for 1 yr. $= £53.\ 15s.\ 8d.$:

and $£53.\ 15s.\ 8d. \times 4\frac{1}{2} = £242.\ 0s.\ 6d.$:

and the amount $= £1317.\ 13s.\ 10d.$

(10) Here, the amount in 4 years, $£607.\ 15s.\ 0\frac{3}{4}d.$

(11) Here, $100\frac{1}{4} : 1102\frac{3}{4} :: 100 : x$;

or, $x = \frac{1102\frac{3}{4} \times 100}{100\frac{1}{4}} = £1100$;

and the income $= 11 \times 3 = £33$.

(12) Here, $£\frac{5}{6} = \frac{100}{6} s. = 16s.\ 8d.$:

and $\frac{11}{10}$ gui. $= \frac{210}{11} s. = 23s.\ 1\frac{1}{5}d.$:

then, the sum $= £1.\ 19s.\ 9\frac{1}{5}d.$:

the difference $= £0.\ 6s.\ 5\frac{1}{5}d.$

XXI.

(1) See Book.

(2) Here, the G. C. M. $= 357$.

(3) Here, the first $= \frac{7}{12}$ is the greatest:

the last $= \frac{31}{60}$ is the least:

also, $\frac{7+13+19+31}{12+24+36+60} = \frac{70}{132}$:

and the greatest $= \frac{77}{132} = \frac{385}{660}$, the least $= \frac{341}{660}$;

and $\frac{70}{132} = \frac{350}{660}$ lies between them.

(4) Here, £2. 12*s*. $2\frac{1}{4}$*d*. = £2.609375.

(5) Here, £1. 10*s*. $4\frac{1}{2}$*d*. = 1458*f*.: £.84375 = 810*f*.:

and required fraction $= \frac{810}{1458} = \frac{5}{9}$.

Again, £.365625 = 7.3125*s*.:

and .3489583gui. = 7.3281243*s*.:

and the difference = .0056243*s*.

(6) Here, $\frac{1}{3} + \frac{1}{5} = \frac{8}{15}$ and the remainder $= \frac{7}{15}$:

also, $\left(\frac{2}{7} - \frac{2}{9}\right)$ of $\frac{7}{15} = \frac{4}{135}$:

that is, $\frac{4}{135}$ of the sum = £70:

and ∴ the sum itself $= \frac{70 \times 135}{4}$ = £2362. 10*s*.:

then the sum paid $= \frac{8}{15}$ of £2362. 10*s*. = £1260:

the sum retained $= \frac{7}{15}$ of £2362. 10*s*. = £1102. 10*s*.

(7) In 1855, the number of inmates $= \frac{4}{3}$: the allowance to each $= \frac{5}{6}$; the price of provisions $= 1 - \frac{1}{10} = \frac{9}{10}$:

then, £2000 : x :: $1 \times 1 \times 1$: $\frac{4}{3} \times \frac{5}{6} \times \frac{9}{10}$;

or, $x = £2000 \times \frac{4}{3} \times \frac{5}{6} \times \frac{9}{10} = £2000$.

(8) Here, the amount of £1200 in 4 years at 4 per cent. = £1200 + £192 = £1392:

and the amount of £1160 in 4 years at 5 per cent.

= £1160 + £232 = £1392.

(9) Here, £2500 + £2700 + £2900 = £8100.

Then, first share $= \frac{2500}{8100}$ of 1620 = £500:

second share $= \frac{2700}{8100}$ of 1620 = £540:

third share $= \frac{2900}{8100}$ of 1620 = £580:

and the sum of these = £1620.

(10) Here, $\sqrt{16.777216} = 4.096$,

and $\sqrt[3]{16.777216} = 2.56$.

Also, $1\frac{1}{24}$ + square of $1\frac{1}{24} = \frac{25}{24} + \left(\frac{25}{24}\right)^2$

$= \frac{1225}{24^2}$, and its square root $= \frac{35}{24}$:

also, $\left(\frac{25}{24}\right)^2 - \frac{25}{24} = \frac{25}{24^2}$ and its square root $= \frac{5}{24}$:

then, $\frac{5}{24} \times 7 = \frac{35}{24}$.

(11) See Book.

(12) Here, 124 ft. 84 in. $= 124\frac{84}{144} = 124\frac{7}{12}$ ft.:

also, 31 ft. 8 in. $= 31\frac{8}{12} = 31\frac{2}{3}$ ft.:

$\therefore$ quantity dug out $124\frac{7}{12} \times 31\frac{2}{3} = \frac{1495}{12} \times \frac{95}{3}$

$= \frac{142025}{36} = 3945\frac{5}{36}$ in. $=$ 2 cubic feet, $489\frac{5}{36}$ cubic in.

XXII.

(1) Here, $\frac{1}{70} = .0\dot{1}4285\dot{7}$:

also, $\frac{3s.\ 7\frac{1}{2}d.}{2s.\ 6d.} = \frac{174}{120} = \frac{58}{40} = \frac{29}{20} = 1.45.$

(2) Here, $12\frac{25}{28}$ cwts. : 6 cwts. :: £$37\frac{1}{15}$: x,

or, $x = £\frac{6 \times 37\frac{1}{15}}{12\frac{25}{28}} = \frac{222\frac{2}{5}}{12\frac{25}{28}} = £\frac{31136}{1805} = £17\frac{451}{1805}$.

(3) Here, 96000000 : 76000000000 :: 8′.13″ : x,

or, $x = 390291\frac{2}{3}$ seconds.

(4) Here, $\frac{1}{4} + \frac{1}{3} = \frac{7}{12}$, and $1 - \frac{7}{12} = \frac{5}{12}$ above the water:

that is, $\frac{5}{12}$ of it is 10 ft., and the whole

$$= \frac{10 \times 12}{5} = \frac{120}{5} = 24 \text{ ft.}$$

(5) Here, $\frac{1}{8} + \frac{1}{12} = \frac{5}{24}$: then

$\frac{5}{24}$: 1 :: 1 : time required:

or, time required $= \frac{24}{5} = 4$ min. 48 seconds.

(6) Here,

$176 \times 19 : 50 \times$ required time :: 4180 lbs. : $1991\frac{1}{4}$ lbs.

or, required time $= \dfrac{176 \times 19 \times 1991\frac{1}{4}}{50 \times 4180} = 31\frac{43}{80}$ dys.

(7) Here $2\frac{1}{2} : 5$ :: third term : 9;

or, the third term $= \dfrac{2\frac{1}{2} \times 9}{5} = \dfrac{9}{2} = 4\frac{1}{2}$.

(8) Here, $\left(\dfrac{9}{10} + 2\frac{1}{2}\right) - (2\frac{3}{5} - 1\frac{3}{4}) \times \{(5\frac{1}{4} \times 7\frac{3}{5})\} \div 16\frac{1}{10}$

$= \dfrac{34}{10} - \dfrac{17}{20} \times \dfrac{10}{4} = \dfrac{17}{5} - \dfrac{17}{8} = \dfrac{136 - 85}{40} = 1\frac{11}{40}$.

(9) Here, $\dfrac{1}{5}$ of a sheep $= 13s.\ 4d.$:

$\therefore$ the value of 1 sheep $= £3.\ 6s.\ 8d.$:

also, $\dfrac{1}{14}$ of an ox $= \dfrac{3}{7}$ of $£3.\ 6s.\ 8d.$,

and the value of 100 oxen $= \dfrac{3}{7}$ of $£3.\ 6s.\ 8d. \times 1400$

$= £3.\ 6s.\ 8d. \times 600 = £3\frac{1}{3} \times 600 = £2000$.

(10) Here, the content of the vessel

$= 4\frac{2}{5} \times 3\frac{2}{3} \times 3$ ft. $= 154 \times 576$ in. :

then, the number of gallons

$$= 154 \times 576 \div 2772 = \frac{770 \times 576}{1386}$$

$$= \frac{110 \times 576}{198} = \frac{10 \times 576}{18} = 10 \times 32 = 320.$$

(11) Here, $6000 \times 5 = 30000$;

$5000 \times 6 = 30000$;

$4000 \times 7\frac{1}{2} = 30000$;

$2500 \times 12 = 30000$:

and since these results are equal, it is evident that £1190 must be divided into 4 equal parts, so that each share

$$= \frac{1}{4} \text{ of } £1190 = £297.\ 10s.$$

(12) Here, the length = 17 ft. 7 in.; then the other dimensions are $\frac{1}{2}$ of 17 ft. 7 in., and $\frac{1}{3}$ of 17 ft. 7 in.: now, the area of the walls = twice the sum of the length and breadth × the height

$$= 2\{17 \text{ ft. } 7 \text{ in.} + \frac{1}{2} \text{ of } 17 \text{ ft. } 7 \text{ in.}\} \times \frac{1}{3} \text{ of } 17 \text{ ft. } 7 \text{ in.}$$

$$= 17 \text{ ft. } 7 \text{ in.} \times 17 \text{ ft. } 7 \text{ in.} = 309 \text{ ft. } 2'.1''.$$

XXIII.

(1) Here, £231. 10*s.* : £6. 15*s.* 0½*d.* :: £1 : *x*;
or, $x = 7d.$

(2) Here, £1. 2*s.* 4½*d.* = 1074*f.*:
and £0. 18*s.* 7¾*d.* = 895*f.*:
then, the fraction required $= \frac{1074}{895} = \frac{6}{5} = 1.2.$

(3) Here, $\frac{1797}{2048}$ cwt. $= 98\frac{35}{128}$ lbs.:

also, .234375 yds. = 2 ft. $15\frac{3}{4}$ in.

(4) Here, the G. C. M. = 12345:

and $\frac{135795}{444420} = \frac{11}{36} = \frac{44}{144}$.

(5) Here, the sum $= 21\frac{1}{3} + 12\frac{4}{5} = \frac{512}{15}$:

and the difference $= 21\frac{1}{3} - 12\frac{4}{5} = \frac{128}{15}$:

whence, the number of times $= \frac{512}{15} \div \frac{128}{15} = 4.$

(6) Here, $10\frac{1}{2}$ knots $= 10\frac{1}{2} \times \frac{7}{6} = 12\frac{1}{4}$ mi.; and the number of hours required $= 3125 \div 12\frac{1}{4} = 255\frac{5}{49}$.

(7) Here, $£3\frac{1}{2} : £105 :: £98 : x$; or, $x = \frac{105 \times 98}{3\frac{1}{2}}$ $= £2940$.

(8) Here, the value of 40 sheep $= £75$; and the value of 6 oxen $= £75 + £15 = 90$; or, the value of an ox $= £15$.

(9) Here, $16 \times 10 : 56 \times x :: 36 : 63$; or, $x = 5$ days.

(10) Here, the value $= £241.\ 2s.\ 6\frac{5}{16}d.$

(11) Here, 6 cwt. 3 qrs. 22 lbs. $= 778$ lbs., and 2.045 of 778 lbs. $= 14$ cwt. $23\frac{1}{100}$ lbs.

(12) Here, interest for 12 mo. $= £2.\ 14s.\ 5\frac{1}{2}d.\ \frac{8}{25}f.$, and the interest for 4 mo. $= £0.\ 18s.\ 1\frac{3}{4}d.\ \frac{11}{25}f.$, also, amount of £100 in 4 mo. at 3 per cent. $= £101$, then, $£101 : £90.\ 15s.\ 6d. :: £1 : x$; or, $x = £0.\ 17s.\ 11\frac{1}{4}d.$ $\frac{82}{101}f.$, and the difference $= 2\frac{1}{4}d.$ nearly.

I.

(1) Here, the whole cost $£93 + £3.\ 12s. = £96.\ 12s.$

(2) Here, $2\frac{1}{7} + 4\frac{5}{8} + 1\frac{1}{4} - 2\frac{5}{14}$ of $\frac{9}{14} = 6\frac{107}{392}$.

(3) Here, $\left(\frac{1}{2} + \frac{2}{7} - \frac{3}{8}\right)$ of $£64.\ 8s. = £26.\ 9s.$; also $\frac{1}{3}$ of $\frac{2}{5}$ of $\frac{11}{15}$ of $7\frac{1}{2}$ gui. $= 15s.\ 4\frac{4}{5}d.$

(4) Here, $x = .184375$, and $x = .925$.

(5) Here, $4\frac{1}{2}$ m. : $17\frac{3}{4}$ m. :: 1 hr. 20 m. : x, or, $x = 5$ hrs. 15 min. $33\frac{1}{3}$ sec.

(6) Here, 8 knots $= 8 \times \frac{7}{6} = 9\frac{1}{3}$ mi.: then, time required $= 3000 \div 9\frac{1}{3} = 321\frac{3}{7}$ hrs.

(7) Here, £1346. 3*s*. 1*d*. × 52 = £70000. 0*s*. 4*d*.; then, $\frac{1}{2}$ of this = £35000. 0*s*. 2*d*., and 1000000 : 100 :: £35000. 0*s*. 2*d*. : x; or, x = £3. 10*s*. nearly.

(8) Here, original income $= \frac{3}{100}$ of £20800 = £624: also, the new stock × 104 = 20800 × 93, or, the new stock $= \frac{20800 \times 93}{104}$ = £18600, and the new income $= \frac{3\frac{1}{2}}{100}$ × £18600 = £651; so that his gain in income = £27.

(9) Here, 1 bush. : 1 qr. 3 bush. 2 pks. :: 5*s*. 6*d*. : x; or, x = £8. 3*s*. 3*d*.; ∴ £3. 3*s*. 3*d*. × 84 = £265. 13*s*.

(10) Here, the first income is greater or less than the second, according as $\frac{3}{89\frac{1}{2}}$ is greater or less than $\frac{3\frac{1}{2}}{98\frac{1}{2}}$, according as $\frac{6}{179}$ is greater or less than $\frac{7}{197}$, according as 6 × 197 is greater or less than 7 × 179, according as 1182 is greater or less than 1253; therefore the latter is the more advantageous.

(11) Here, the area of the floor $= 29\frac{1}{2} \times 14\frac{1}{4} = \frac{59}{2} \times \frac{57}{4} = \frac{3363}{8}$ feet; also, the length of the carpet × $\frac{5}{8}$ yds. $= \frac{3363}{8}$ feet: that is, the length of the carpet $= \frac{3363}{8} \div \frac{15}{8} = \frac{1121}{5} = 224\frac{1}{5}$ ft., and, 3 ft. : $\frac{1121}{5}$ ft. :: 42*d*. : the cost required; or, the cost required $= \frac{1121}{5} \times \frac{42}{3} = \frac{1121}{5}$ × 14 = 3138$\frac{4}{5}$*d*. = £13. 1*s*. 6$\frac{4}{5}$*d*.

(12) Here, $1\frac{56}{169} = \frac{225}{169}$ whose square root $= \frac{15}{13} = 1\frac{2}{13}$.

Again,

$$\begin{array}{rl} & 1\dot{9}5\dot{3}1\dot{2}\dot{5} \;(125 = \text{cube root.} \\ & 1 \\ \hline 1^2 \times 300 = 300) & 953 \\ & 600 \\ 2^2 \times 1 \times 30 = & 120 \\ 2^3 = & 8 \\ \hline & 728 \\ \hline 12^2 \times 300 = 43200) & 225125 \\ & 216000 \\ \hline 5^2 \times 12 \times 30 = & 9000 \\ 5^3 = & 125 \\ \hline & 225125 \\ \hline \end{array}$$

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